Job-shop Planning:

From	To		Prob	From	To		Prob	From	To		Prob	From	To		Prob	From	To		Prob
initial	X-ray Dept.	1	0.5	X-ray Dept.	Operating Room	1	0.1	Operating Room	Cast-Fitting	1	0.3		Observation	1	0.6	Observation	Operating Room	1	0.15
	Operating Room	2	0.2		Cast-Fitting	2	0.3		Observation	2	0.7		X-ray Dept.	2	0.1		X-ray Dept.	2	0.15
	Observation	3	0.1		Observation	3	0.4		Out-Processing Clerk	3	0.1		Out-Processing Clerk	3	0.4		Out-Processing Clerk	3	0.7
	Out-Processing Clerk	4	0.3		Out-Processing Clerk	4	0.3												

	Random #s																		
	1			1				1				1				1			
	1			1				1				1				1			
RNs	1			2				1				3				2			
	2			3				2				1				3			
	4			4				2				3				3			

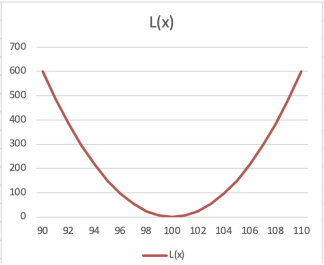
Patient#1	
From	To
initial	X-ray Dept.
X-ray Dept.	Operating Room
Operating Room	Cast-Fitting
Cast-Fitting	Observation
Observation	Operating Room
Operating Room	Cast-Fitting
Cast-Fitting	Observation
Observation	Operating Room
Operating Room	Cast-Fitting
Cast-Fitting	Out-Processing Clerk

Patient#2	
From	To
initial	X-ray Dept.
X-ray Dept.	Operating Room
Operating Room	Observation
Observation	X-ray Dept.
X-ray Dept.	Cast-Fitting
Cast-Fitting	Observation
Observation	Out-Processing Clerk
Out-Processing Clerk	

Quality Control: The uniform is for between and normal: mean and SD. We use the same formula for the cost as for L(x).

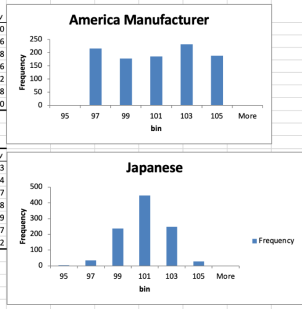
E12

	A	B	C
1	Tacguchi Loss Function, loss due to poor product quality is given by	x	L(x)
2	L(x)=C(x-T)^2, where	90	600
3	T is the target measurement for the product	91	486
4	L(x) equals the expected quality loss incurred by the company if a product with measurement x is produced.	92	384
5	C is used to calibrate the loss function.	93	294
6	$150 = L(105)=C (105-100)^2 ➔ C=150/25=$6	94	216
7	⇨ L(x)=6 (x-100)^2	95	150
8	In tab "simulation quality", run a single simulation to make recommendations on which TV has a better quality.	96	96
9	Find the mean, std, 99.73% lower & upper CI.	97	54
10		98	24
11		99	6
12		100	0
13		101	6
14		102	24
15		103	54
16		104	96
17		105	150
18		106	216
19		107	294
20		108	384
21		109	486
22		110	600



for the cost do 2 decimals and none for distributions. For the hist, data analysis, hist, input: distribution, bin, chart output, labels.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1		American Uniform(95,105)	Cost		Japanese Normal(100,1.67)	Cost		bin		bin	Frequency							
2		95	149.25		95	152.92		95		95	0							
3		101	2.43		100	0.43		97		97	216							
4		97	56.44		99	12.54		99		99	178							
5		103	57.19		101	12.76		101		101	186							
6		101	4.34		100	0.77		103		103	232							
7		100	0.24		100	0.04		105		105	188							
8		99	13.45		99	2.47				More	0							
9		104	94.07		102	26.52												
10		103	62.54		102	14.36												
11		102	36.49		101	7.37												
12		97	63.72		98	14.72				bin	Frequency							
13		104	77.30		102	19.36				95	3							
14		102	26.59		101	5.15				97	34							
15		100	0.11		100	0.02				99	237							
16		98	23.05		99	4.40				101	448							
17		95	141.14		96	78.83				103	249							
18		96	100.17		98	29.70				105	27							
19		99	11.02		99	2.01				More	2							
20		96	74.63		98	18.38												
21		97	66.97		98	15.76												
22		105	143.19		104	86.55												
23		99	1.77		100	0.31												
24		96	87.06		98	23.28												



In the end, do this for cost:

mean:=AVERAGE(C2:C1001), **STD**: =STDEV.S(C2:C1001), **Lower CI**:=C1002-NORM.S.INV(0.9973+(1-0.9973)/2)*C1003/SQRT(1000) , **Upper CI**:=C1002+NORM.S.INV(0.9973+(1-0.9973)/2)*C1003/SQRT(1000) , **Diff UB-LB**: =C1005-C1004.

Corporate Financial Planning: Model 1-car Type1: Fixed cost: rng, 1, 50, discrete, value and probability, the same for Variable Cost and demand year 0. **Error ~ N(0,20000)**: RNG, 1, 50, normal, mean and SD. **Simulated Demand:** =$M20+C20,(M20:demand Year 0, C20: in Error, Year1). **Net Cash Value (NCV): Year 0:** =-A20(Fixed cost for Car 1), **Year 1-10:** =(price-$B20)*N20 (B20:Variable Cost for Car 1; N20: in simulated demand, year 1). **Net Present Value:** =(X20+NPV(rate,Y20:AH20))/1000, (X20 is Year0, Y20:AH20 is 1-10 years). **After NPV: mean**:=AVERAGE(AI20:AI49), **STD**: =STDEV.S(AI20:AI49),**Z-Val:**=NORM.S.INV(AG54+(1-AG54)/2) , **Lower CI**:=AI52-AI54*AI53/SQRT(30) , **Upper CI**:=AI52+AI54*AI53/SQRT(30). **Model 2-car Type1: Fixed and Variable cost:** ='Model 1-car Type1 '!A20, ='Model 1-car Type1 '!B20, **Error ~ N(0,20000)**: ='Model 1-car Type1 '!C20, **Sales:** ='Model 1-car Type1 '!M20, **Simulated Demand:** Year 1: =M20+C20, Year 2: =N20+D20, **Net Cash Value (NCV):** Year 0: =-A20(Fixed cost), Year 1-10: =(price-$B20)*N20, =(price-$B20)*O20, etc. **Net Present Value:** =(X20+NPV(rate,Y20:AH20))/1000, (X20 is Year0, Y20:AH20 is 1-10 years). **After NPV: mean**:=AVERAGE(AI20:AI49), **STD**: =STDEV.S(AI20:AI49),**Z-Val:**=NORM.S.INV(AG54+(1-AG54)/2) , **Lower CI**:=AI52-AI54*AI53/SQRT(30) , **Upper CI**:=AI52+AI54*AI53/SQRT(30).

Model 3-car Type1:Fixed and Variable cost: ='Model 1-car Type1 '!A20, ='Model 1-car Type1 '!B20, **Error ~ N(0,20000)**: ='Model 1-car Type1 '!C20, **Sales:** ='Model 1-car Type1 '!M20, **Simulated Demand:** Year 1:=growth*M20+C20, **Net Cash Value (NCV):** Year 0: =-A20(Fixed cost),Year 1-10: =(price-$B20)*N20, =(price-$B20)*O20, etc.**Net Present Value:** =(X20+NPV(rate,Y20:AH20))/1000, (X20 is Year0, Y20:AH20 is 1-10 years).**After NPV: mean**:=AVERAGE(AI20:AI49), **STD**:=STDEV.S(AI20:AI49),**Z-Val:**=NORM.S.INV(AG54+(1-AG54)/2) , **Lower CI**:=AI52-AI54*AI53/SQRT(30) , **Upper CI**:=AI52+AI54*AI53/SQRT(30). **Compare:** Write mean, STD, Upper CI, and Lower CI from three models and then compare: CI upper-

CI Lower for each model: =B5-B4, =C5-C4, =D5-D4

General Ford (GF) Auto Corporation is trying to determine what type of compact car to develop. Two types of cars (Car 1 & Car 2) are under consideration. Each model is assumed to generate sales for 10 years. In order to determine which compact ca type should be built, information about the following quantities has been gathered through focus groups with the marketing and engineering departments.

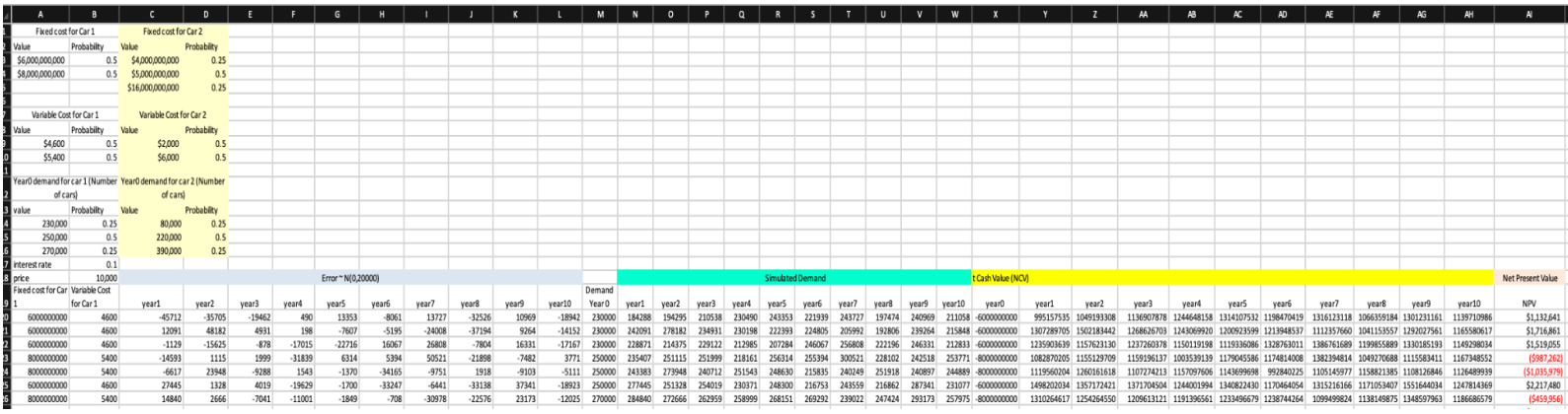
Fixed Cost of Developing Car: This cost is assumed to be incurred at he beginning of year 1 (or end of year 0) before any sales are recorded		
Variable Production Cost: The variable cost incurred in producing a car		
Sales Price: The sales price is assumed to be $10,000 for each model		
Demand During Each of Next 10 years: For simplicity we'll assume that all sales occur at the end of each year.		
Interest Rate: It's assumed that cash flows are discounted at 10%. This means that a cash outflow of 1$ at the beginning of year 1 is equivalent to a cash outflow of $1.10 at the end of Year 1.		
Fixed and variable costs and annual sales are unknown. The views of marketing and engineering about these quantities are summarized in each worksheet A1:D18.		
For simplicity, we assume that the variable cost for each year's production is the same. This ignores inflation.		

If car sells well the first year, it probably will sell well during the later years. GF has 3 models to compare:

MODEL/APPROACH 1: Based on Year 0 demand	MODEL/APPROACH 2:	MODEL/APPROACH 3: Assume demand grows by 5% yearly
Demand (Year t) = Expected demand (Year 0) + Error Term	**Demand (Year t) = Demand (Year t-1) + Error Term**	**Demand (Year t) = 1.05 * Demand (Year t-1) + Error Term**

Assume that errors are normally distributed random number with mean 0 and standard deviation 20,000

How do we use simulation to compare the merits of the two proposed compact car types?



Fixed cost for Car 1		Fixed cost for Car 2	
Value	Probability	Value	Probability
$6,000,000,000	0.5	$4,000,000,000	0.25
$8,000,000,000	0.5	$5,000,000,000	0.5
		$16,000,000,000	0.25

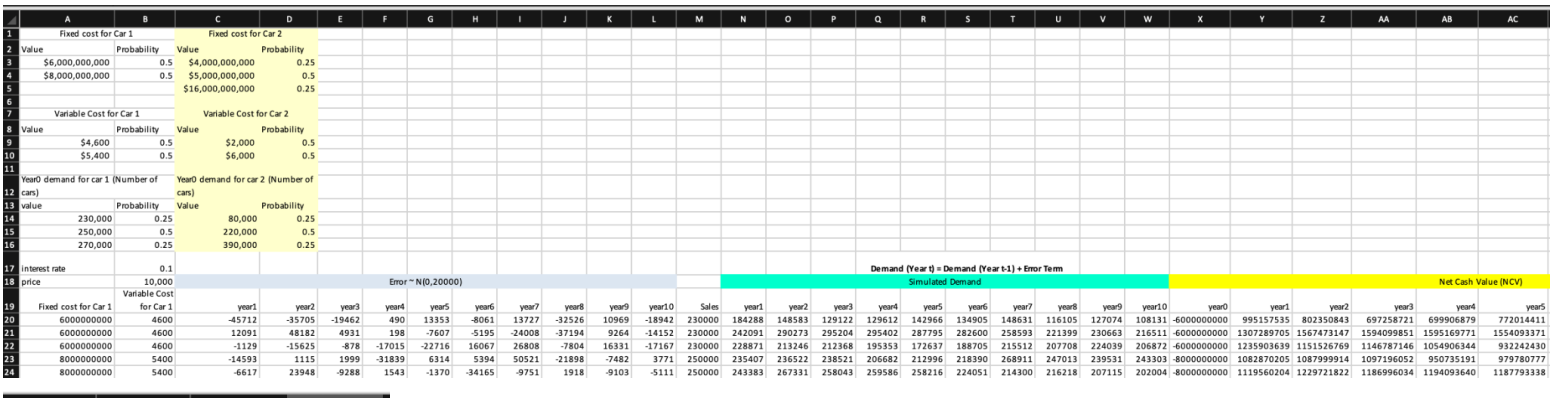
Variable Cost for Car 1		Variable Cost for Car 2	
Value	Probability	Value	Probability
$4,600	0.5	$2,000	0.5
$5,400	0.5	$6,000	0.5

Year0 demand for car 1 (Number of cars)		Year0 demand for car 2 (Number of cars)	
value	Probability	Value	Probability
230,000	0.25	80,000	0.25
250,000	0.5	220,000	0.5
270,000	0.25	390,000	0.25

interest rate 0.1

price 10,000 — Error ~ N(0,20000) — Simulated Demand — t Cash Value (NCV) — Net Present Value

Fixed cost for Car 1	Variable Cost for Car 1	Demand Year 0	year1	year2	year3	year4	year5	year6	year7	year8	year9	year10	year0	year1	year2	year3	year4	year5	year6	year7	year8	year9	year10	NPV
6000000000	4600	230000	-45712	-35705	-19462	490	13353	-8061	13727	-32526	10969	-18942	230000	184288	194295	210538	230490	243353	221939	243727	197474	240969	211058	-6000000000	995157535	1049193308	1136907878	1244648158	1314107532	1198470419	1316123118	1066359184	1301231161	1139710986	$1,132,641
6000000000	4600	242091	12091	48182	4931	198	-7607	-5195	-24008	-37194	9264	-14152	230000	242091	278182	234931	230198	222393	224805	205992	192806	239264	215848	-6000000000	1307289705	1502183442	1268626703	1243069920	1200923599	1213948537	1112357660	1041153557	1292027561	1165580617	$1,716,861
6000000000	4600	228871	-1129	-15625	-878	-17015	-22716	16067	26808	-7804	16331	-17167	230000	228871	214375	229122	212985	207284	246067	256808	222196	246331	212833	-6000000000	1235903639	1157623130	1237260378	1150119198	1119336086	1328763011	1386761689	1199855889	1330185193	1149298034	$1,519,055
8000000000	5400	235407	-14593	1115	1999	-31839	6314	5394	50521	-21898	-7482	3771	250000	235407	251115	251999	218161	256314	255394	300521	228102	242518	253771	-8000000000	1082870205	1155129709	1159196137	1003539139	1179045586	1174814008	1382394814	1049270688	1115583411	1167348552	($987,262)
8000000000	5400	243383	-6617	23948	-9288	1543	-1370	-34165	-9751	1918	-9103	-5111	250000	243383	273948	240712	251543	248630	215835	240249	251918	240897	244889	-8000000000	1119560204	1260161618	1107274213	1157097606	1143699698	992840225	1105145977	1158821385	1108126846	1126489939	($1,035,979)
6000000000	4600	277445	1328	4019	-19629	-1700	-33247	-6441	-33138	37341	-18923	250000	277445	251328	254019	230371	248300	216753	243559	216862	287341	231077	-6000000000	1498202034	1357172421	1371704504	1244001994	1340822430	1170464054	1315216166	1171053407	1551644034	1247814369	$2,217,480
8000000000	5400	284840	14840	2666	-7041	-11001	-1849	-708	-30978	-22576	23173	-12025	270000	284840	272666	262959	258999	268151	269292	239022	247424	293173	257975	-8000000000	1310264617	1254264550	1209613121	1191396561	1233496679	1238744264	1099499824	1138149875	1348597963	1186686579	($459,956)



Fixed cost for Car 1		Fixed cost for Car 2	
Value	Probability	Value	Probability
$6,000,000,000	0.5	$4,000,000,000	0.25
$8,000,000,000	0.5	$5,000,000,000	0.5
		$16,000,000,000	0.25

Variable Cost for Car 1		Variable Cost for Car 2	
Value	Probability	Value	Probability
$4,600	0.5	$2,000	0.5
$5,400	0.5	$6,000	0.5

Year0 demand for car 1 (Number of cars)		Year0 demand for car 2 (Number of cars)	
value	Probability	Value	Probability
230,000	0.25	80,000	0.25
250,000	0.5	220,000	0.5
270,000	0.25	390,000	0.25

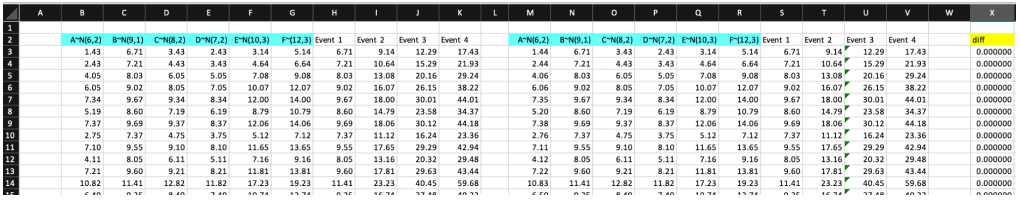
interest rate 0.1

price 10,000 — Error ~ N(0,20000) — Demand (Year t) = Demand (Year t-1) + Error Term — Simulated Demand — Net Cash Value (NCV)

Fixed cost for Car 1	Variable Cost for Car 1	Sales	year1	year2	year3	year4	year5	year6	year7	year8	year9	year10	year0	year1	year2	year3	year4	year5	year6	year7	year8	year9	year10	year0	year1	year2	year3	year4	year5
6000000000	4600	230000	184288	148583	129122	129612	142966	134905	148631	116105	127074	108131	-6000000000	995157535	802350843	697258721	699906879	772014411											
6000000000	4600	230000	242091	290273	295204	295402	287795	282600	258593	221399	230663	216511	-6000000000	1307289705	1567473147	1594099851	1595169771	1554093371											
6000000000	4600	230000	228871	213246	212368	195353	172637	188705	215512	207708	224039	206872	-6000000000	1235903639	1151526769	1146787146	1054906344	932242430											
8000000000	5400	250000	235407	236522	238521	206682	212996	218390	268911	247013	239531	243303	-8000000000	1082870205	1087999914	1097196052	950735191	979780777											
8000000000	5400	250000	243383	267331	258043	259586	258216	224051	214300	216218	207115	202004	-8000000000	1119560204	1229721822	1186996034	1194093640	1187793338											

	Model 1	Model 2	Model 3
MEAN	776,998	650,842	2,702,844
STD	1,333,255	1,818,063	2,028,555
CI lower	376,611	104,863	2,093,653
CI upper	1,177,385	1,196,820	3,312,035
diff	800,774	1,091,957	0

Project Management: **var:** sd^2, **VarofProject:**SUM(D3,D5,D6,D7), **STDofProject (stdp):**SQRT(var of proj), **Project Expected Time:**SUM(B3,B5,B6,B7)(sum of means).**P(T<40days)**=P((T-meanp)/std<(40-38)/4.80)=P(Z <.42):=(A18-meanp)/sd. **P(T>45 days)**=1-P(T<=45days)=1-P(Z<=(45-38)/4.80)=1-P(Z<=1.46):(A22-meanp)/sd. **check three different ways: P(T<40days):**NORM.DIST(F18,0,1,TRUE), =NORM.DIST(A18,meanp,sigmap,TRUE),NORM.S.DIST(F18, TRUE),**P(T>45 days):** 1-NORM.DIST(F22,0,1,TRUE),1-NORM.DIST(A22,meanp,sigmap,TRUE), 1-NORM.S.DIST(F22, TRUE).
Critical Path: A~N(6,2), B~N(9,1),C~N(8,2),D~N(7,2),E~N(10,3),F~(12,3): RNG, Normal dist.
Event1:MAX(B3,C3),**Event2:**H3+E3,**Event3:**MAX(H3+D3,I3+F3),**Event4:**J3+G3.
test activity A: copy everything from crit path: ='critical path'!B3,then create same **A~N(6,2) and Event 1-4**, for 1st dist:B3+0.01, for rest: =C3, =D3, etc. events same, after events create column **diff:**=V3-K3(Event4-Event4),end:=AVERAGE(X2:X1002)/0.01.for events for find ave:AVERAGE(K3:K1002). **test activity B:**do same from act A, but for 2nd dist:C3+0.01,**test activity C:** do same from act A, but for 2nd dist:D3+0.01,**test activity D:**do same from act A, but for 2nd dist:E3+0.01,**test activity E:**do same from act A, but for 2nd dist:F3+0.01,**test activity F:**do same from act A, but for 2nd dist:G3+0.01. Var is critical when diff 0.01.



A~N(6,2)	B~N(9,1)	C~N(8,2)	D~N(7,2)	E~N(10,3)	F~(12,3)	Event 1	Event 2	Event 3	Event 4	A~N(6,2)	B~N(9,1)	C~N(8,2)	D~N(7,2)	E~N(10,3)	F~(12,3)	Event 1	Event 2	Event 3	Event 4	diff
1.43	6.71	3.43	2.43	3.14	5.14	6.71	9.14	12.29	17.43	1.44	6.71	3.43	2.43	3.14	5.14	6.71	9.14	12.29	17.43	0.000000
2.43	7.21	4.43	3.43	4.64	6.64	7.21	10.64	15.29	21.93	2.44	7.21	4.43	3.43	4.64	6.64	7.21	10.64	15.29	21.93	0.000000
4.05	8.03	6.05	5.05	7.08	9.08	8.03	13.08	20.16	29.24	4.06	8.03	6.05	5.05	7.08	9.08	8.03	13.08	20.16	29.24	0.000000
6.05	9.02	8.05	7.05	10.07	12.07	9.02	16.07	26.15	38.22	6.06	9.02	8.05	7.05	10.07	12.07	9.02	16.07	26.15	38.22	0.000000
7.34	9.67	9.34	8.34	12.00	14.00	9.67	18.00	30.01	44.01	7.35	9.67	9.34	8.34	12.00	14.00	9.67	18.00	30.01	44.01	0.000000
5.19	8.60	7.19	6.19	8.79	10.79	8.60	14.79	23.58	34.37	5.20	8.60	7.19	6.19	8.79	10.79	8.60	14.79	23.58	34.37	0.000000
7.37	9.69	9.37	8.37	12.06	14.06	9.69	18.06	30.12	44.18	7.38	9.69	9.37	8.37	12.06	14.06	9.69	18.06	30.12	44.18	0.000000
2.75	7.37	4.75	3.75	5.12	7.12	7.37	11.12	16.24	23.36	2.76	7.37	4.75	3.75	5.12	7.12	7.37	11.12	16.24	23.36	0.000000
7.10	9.55	9.10	8.10	11.65	13.65	9.55	17.65	29.29	42.94	7.11	9.55	9.10	8.10	11.65	13.65	9.55	17.65	29.29	42.94	0.000000
4.11	8.05	6.11	5.11	7.16	9.16	8.05	13.16	20.32	29.48	4.12	8.05	6.11	5.11	7.16	9.16	8.05	13.16	20.32	29.48	0.000000
7.21	9.60	9.21	8.21	11.81	13.81	9.60	17.81	29.63	43.44	7.22	9.60	9.21	8.21	11.81	13.81	9.60	17.81	29.63	43.44	0.000000
10.82	11.41	12.82	11.82	17.23	19.23	11.41	23.23	40.45	59.68	10.83	11.41	12.82	11.82	17.23	19.23	11.41	23.23	40.45	59.68	0.000000

Single Server Queuing System: **IT(interval tme):**-6*LN(RAND()),**ST(service time):**=-4*LN(RAND()),**simulation-phase 1:**Event 0-100, **for IT,ST,TM,SS,#WL,AT,Event0,#INSYS,TIME between events**: 1st row empty,**ET(Event Type(arrival or departure)):**=IF(H2<I2,"Arrival", "Departure"), **IT,ST, TM(current Clock Time):**MIN(H2,I2), **SS(status of the server (0 = idle, 1=busy)):**=IF(J3>0,1,0),**#WL(number of customers waiting in line):**=IF(J3>1,J3-1,0),**AT(time of the next arrival):**=C3, **DT(time of the next departure (set 9999 if the server is idle)):**=D3,**#INSYS(number of customers in the system):**=IF(H2<I2,J2+1,IF(J2=0,0,J2-1)),**TIME between events:**=E4-E3.**simulation-phase 2:** **AT:** =IF(H3<I3,E4+C4,H3), **DT:** =IF(AND(H3>I3,J3>1),E4+D4,IF(AND(H3>I3,J3=1),9999,IF(AND(H3<I3,I3=9999),E4+D4,I3))). **Fraction of time busy:** =SUMPRODUCT(F3:F101(SS),K3:K101(Time between events))/E102, **Average in the system:** =SUMPRODUCT(J3:J101(INSYS),K3:K101(Time between events))/E102(TM).

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
		-lambda*ln(rand())								time				Fraction	
Event #	ET	IT (rv)	ST (rv)	TM	SS	#WL	AT	DT	#INSYS	between events				of time busy	Average in the system
0				0	0	0	0.00	9999.00	0	0				77%	2.76
1	Arrival	4.90	1.13	0.00	1	0	4.90	1.13	1	1.13					
2	Departure	1.89	4.01	1.13	0	0	4.90	9999.00	0	3.76					
3	Arrival	5.92	1.98	4.90	1	0	10.82	6.88	1	1.98					
4	Departure	12.50	0.33	6.88	0	0	10.82	9999.00	0	3.94					
5	Arrival	4.38	12.49	10.82	1	0	15.20	23.31	1	4.38					
6	Arrival	10.74	9.86	15.20	1	1	25.94	23.31	2	8.11					
7	Departure	22.14	0.33	23.31	1	0	25.94	23.65	1	0.33					
8	Departure	0.30	11.55	23.65	0	0	25.94	9999.00	0	2.30					
9	Arrival	1.66	11.32	25.94	1	0	27.60	37.27	1	1.66					
10	Arrival	0.55	0.88	27.60	1	1	28.15	37.27	2	0.55					

Fraction of time busy =

Average in the system