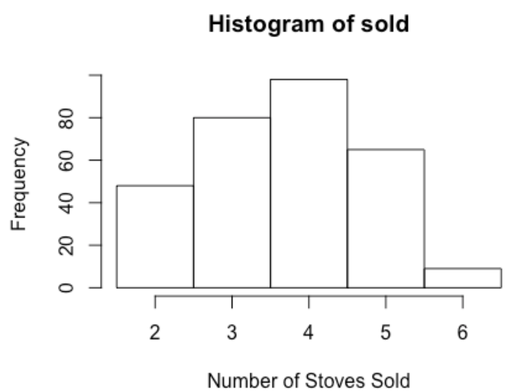
```
# Simulation for Problem 20.1-3e
# To run, click Source (or highlight everything and click Run
from the menu above)

# set.seed(1) # optional - specify a seed to reproduce the
simulation exactly
SimSize=300 # set number of trials in the simulation

sold = c(2,3,4,5,6)
days = c(4,7,8,5,1)
probs = days/sum(days)

sim = sample(sold, size=SimSize, replace=T,prob=probs)
cat("Average sales over 300 simulated days:", mean(sim), sep='')


# Another whay this could be simulated is as follows
# It is less efficient, but works nonetheless

P <- c(.16,.44,.76,.96,1)  # define the cumulative distribution
function probabilities
x <- c(2,3,4,5,6) # establish the corresponding outcomes in the
distribution
nn <- 0  # set simulation clock to 0 to begin simulation
sold <- rep(0,SimSize)

while (nn < SimSize) {

counter <- 1 # restart counter
r <- runif(1,0,1) # generate random number from the U(0,1)
distribution

while(r > P[counter]) {
  counter=counter + 1
}

nn <- nn + 1 # increase the simulation count
sold[nn] <- x[counter] # number of stoves sold for each random
observation


}

# Summarize results for the simulation
mean(sold)
sd(sold)
summary(sold)
```

```
b=c(1.5,2.5,3.5,4.5,5.5,6.5) # specify these breaks for a better
looking histogram
hist(sold,breaks=b,xlab="Number of Stoves Sold")

# Make a nice plot of the probability mass function (optional)
b=c(1.5,2.5,3.5,4.5,5.5,6.5)
relfreq <- hist(sold,plot=F,breaks=b)$density
plot(x,relfreq,type="h",xlab="Number of Stoves
Sold",ylab="Probability")
```

Output:

```
> # Summarize results for the simulation
> mean(sold)
[1] 3.69
> sd(sold)
[1] 1.072879
> summary(sold)
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
   2.00    3.00    4.00    3.69    4.00    6.00
```



20.6-6.

The order quantity that maximizes the mean profit is approximately 55.

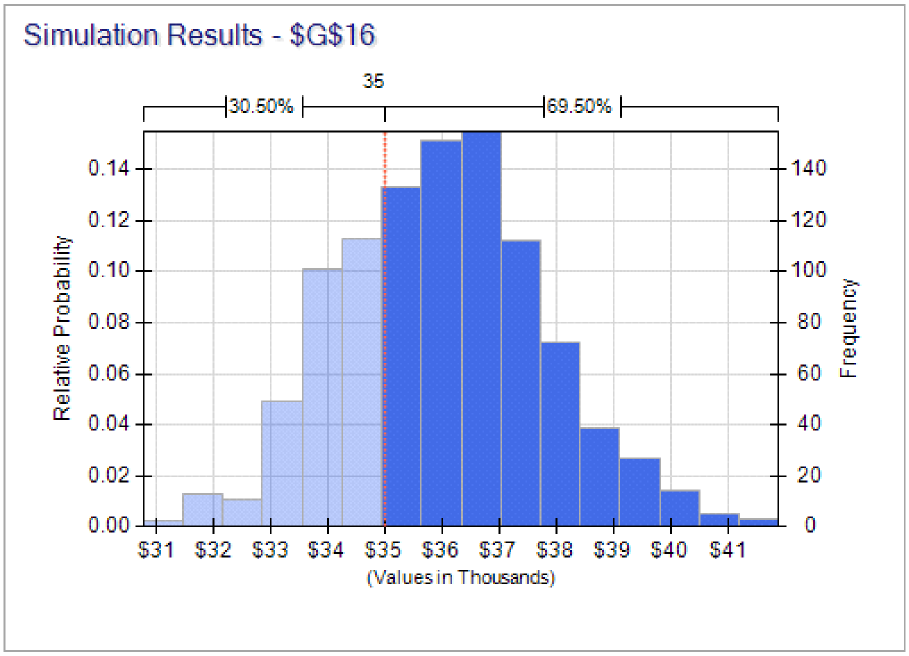
Order Quantity	Mean Profit
50	$46.45
51	$46.74
52	$46.97
53	$47.13
54	$47.22
55	$47.26
56	$47.22
57	$47.13
58	$46.97
59	$46.74
60	$46.45

20.6-7.

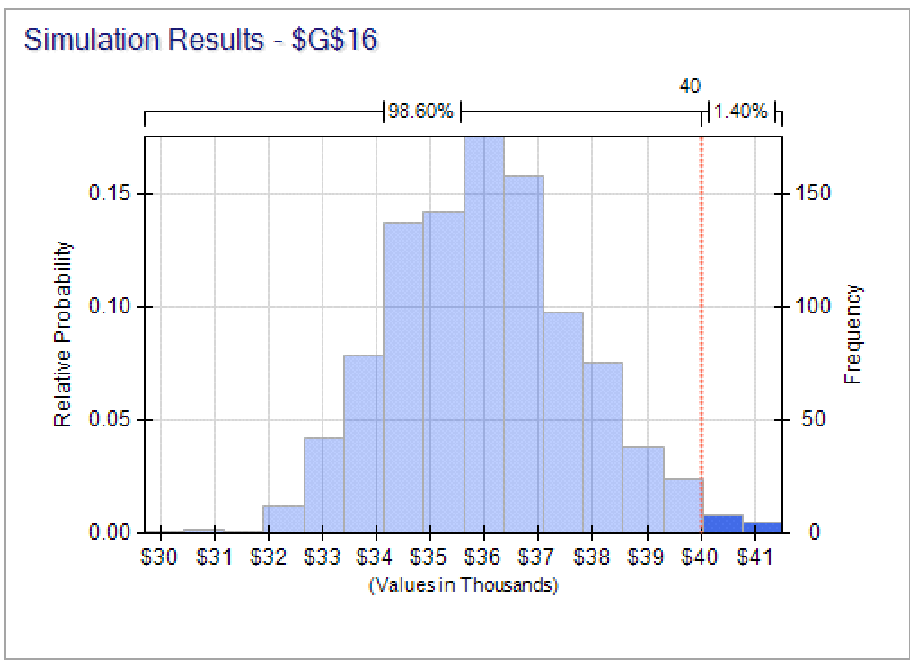
(a) and (b) The expected value of the college fund at year 5 is approximately $36 thousand. The standard deviation of the college fund at year 5 is just over $1700.

	Initial	Annual							
Stock Fund	$3,000	$2,000							
Bond Fund	$3,000	$2,000							
	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5			
Stock Fund Investment	$5,000	$2,000	$2,000	$2,000	$2,000	$2,000			
Stock Fund Start	$5,000	$7,519	$9,962	$12,804	$15,794	$19,738		Mean	St. Dev.
Stock Fund Return (%)	10%	6%	8%	8%	12%		*Normal*	8%	6%
Stock Fund End	$5,519	$7,962	$10,804	$13,794	$17,738				
Bond Fund Investment	$5,000	$2,000	$2,000	$2,000	$2,000	$2,000			
Bond Fund Start	$5,000	$7,298	$9,649	$11,516	$13,722	$16,862			
Bond Fund Return (%)	6%	5%	-1%	2%	8%		*Normal*	4%	3%
Bond Fund End	$5,298	$7,649	$9,516	$11,722	$14,862				
					Total	$36,600			
					Mean	$35,993			
					St. Deviation	$1,729			

(c) The probability that the college fund at year 5 will be at least $35,000 is approximately 69.5%.



(d) The probability that the college fund at year 5 will be at least $40,000 is approximately 1.4%.



```
# Simulation for Problem 20.6-7
# To run, click Source (or highlight everything and click Run from the
menu above)

# set.seed(1) # optional - specify a seed to reproduce the simulation
exactly
SimSize=1000 # set number of trials in the simulation

# Compute the total for the college fund from the stock fund
# do this for all simulation replications in a matrix for each year
s0 <- rep(5000,SimSize) * (rep(1,SimSize) +
rnorm(SimSize,mean=0.08,sd=0.06)) # total for year 0
s1 <- (s0 + 2000) * (rep(1,SimSize) + rnorm(SimSize,mean=0.08,sd=0.06)) #
grand total at end of year 1
s2 <- (s1 + 2000) * (rep(1,SimSize) + rnorm(SimSize,mean=0.08,sd=0.06)) #
grand total at end of year 2
s3 <- (s2 + 2000) * (rep(1,SimSize) + rnorm(SimSize,mean=0.08,sd=0.06)) #
grand total at end of year 3
s4 <- (s3 + 2000) * (rep(1,SimSize) + rnorm(SimSize,mean=0.08,sd=0.06)) #
grand total at end of year 4
stocktotal <- s4 + 2000 # grand total for stock fund after 5 years

# Compute the total for the college fund from the bond fund
b0 <- rep(5000,SimSize) * (rep(1,SimSize) +
rnorm(SimSize,mean=0.04,sd=0.03)) # total for year 0
b1 <- (b0 + 2000) * (rep(1,SimSize) + rnorm(SimSize,mean=0.04,sd=0.03)) #
grand total at end of year 1
b2 <- (b1 + 2000) * (rep(1,SimSize) + rnorm(SimSize,mean=0.04,sd=0.03)) #
grand total at end of year 2
b3 <- (b2 + 2000) * (rep(1,SimSize) + rnorm(SimSize,mean=0.04,sd=0.03)) #
grand total at end of year 3
b4 <- (b3 + 2000) * (rep(1,SimSize) + rnorm(SimSize,mean=0.04,sd=0.03)) #
grand total at end of year 4
bondtotal <- b4 + 2000 # grand total for bond fund after 5 years

grandtotal <- stocktotal + bondtotal

# Summarize results for the simulation
mean(grandtotal)  # answer to part (a) find the expected value (i.e. mean)
sd(grandtotal)  # answer to part (b) find the standard deviation
sum(grandtotal >= 35000)/SimSize  # answer to part (c) find the
probability the total is at least $35000
sum(grandtotal >= 40000)/SimSize  # answer to part (d) find the
probability the total is at least $40000
```

Output:

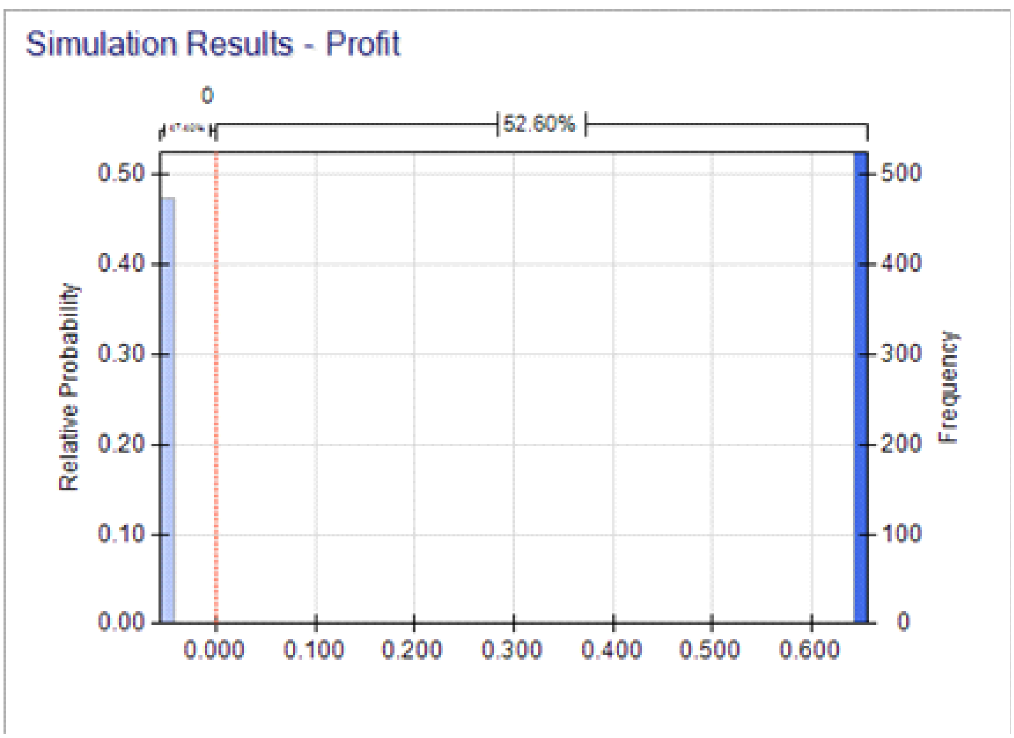
```
> # Summarize results for the simulation
> mean(grandtotal)  # answer to part (a) find the expected value (i.e.
mean)
[1] 36045.98
> sd(grandtotal)  # answer to part (b) find the standard deviation
[1] 1716.243
```

```
> sum(grandtotal >= 35000)/SimSize  # answer to part (c) find the
probability the total is at least $35000
[1] 0.741
> sum(grandtotal >= 40000)/SimSize  # answer to part (d) find the
probability the total is at least $40000
[1] 0.015
```

20.6-9.

(a) The mean profit is approximately $0.3 million. The probability of winning the bid is approximately 52.6%.

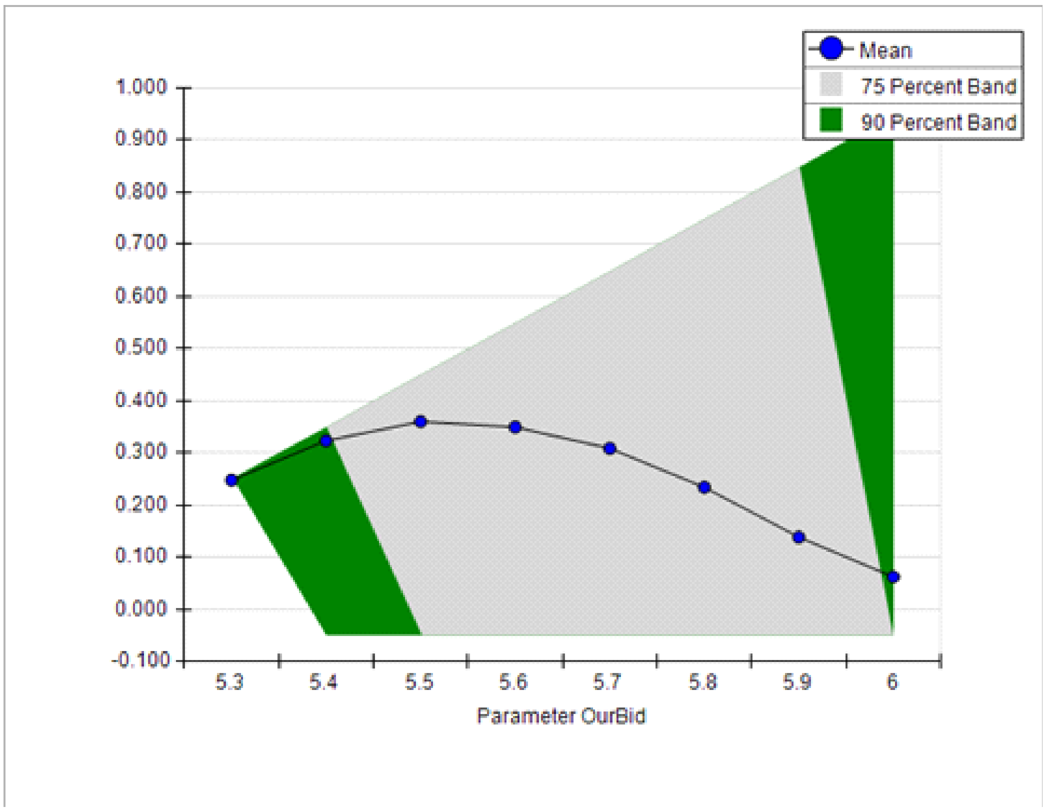
Data				
Our Project Cost ($million)	5.000			
Our Bid Cost ($million)	0.050			
Competitor Bids	Competitor 1	Competitor 2	Competitor 3	Competitor 4
Bid ($million)	5.824	5.959	6.114	6.136
Distribution	*Triangular*	*Triangular*	*Triangular*	*Triangular*
Competitor Distribution Parameters (Proportion of Our Project Cost)				
Minimum	105%	105%	105%	105%
Most Likely	120%	120%	120%	120%
Maximum	140%	140%	140%	140%
Competitor Distribution Parameters ($millions)				
Minimum	5.250	5.250	5.250	5.250
Most Likely	6.000	6.000	6.000	6.000
Maximum	7.000	7.000	7.000	7.000
Minimum Competitor Bid ($million)	5.824			
Our Bid ($million)	5.700			
Win Bid?	1	(1=yes, 0=no)		
Profit ($million)	0.650			
Mean Profit ($million)	0.303			



(b) A bid of approximately $5.5 million maximizes RPI's mean profit.

OurBid	Mean Profit ($million)
5.3	0.248
5.4	0.323
5.5	0.364
5.6	0.356
5.7	0.313
5.8	0.234
5.9	0.140
6.0	0.061

(c)



(d) The optimal bid is approximately $5.57 million, as found by Solver.

Data				
Our Project Cost ($million)	5.000			
Our Bid Cost ($million)	0.050			
Competitor Bids	Competitor 1	Competitor 2	Competitor 3	Competitor 4
Bid ($million)	6.133	5.864	6.312	6.341
Distribution	*Triangular*	*Triangular*	*Triangular*	*Triangular*
Competitor Distribution Parameters (Proportion of Our Project Cost)				
Minimum	105%	105%	105%	105%
Most Likely	120%	120%	120%	120%
Maximum	140%	140%	140%	140%
Competitor Distribution Parameters ($millions)				
Minimum	5.250	5.250	5.250	5.250
Most Likely	6.000	6.000	6.000	6.000
Maximum	7.000	7.000	7.000	7.000
Minimum Competitor Bid ($million)	5.864			
Our Bid ($million)	5.569			
Win Bid?	1	(1=yes, 0=no)		
Profit ($million)	0.519			
Mean Profit ($million)	0.366			

CHAPTER 28: EXAMPLES OF PERFORMING SIMULATIONS ON SPREADSHEETS WITH ANALYTIC SOLVER PLATFORM

28-1.

(a) Answers will vary. A typical set of 5 runs: 45.83, 46.26, 45.94, 45.98, and 46.89.

(b) Answers will vary. A typical set of 5 runs: 46.49, 46.12, 46.38, 46.23, and 46.37.

(c) The mean completion times in part *b* should be more consistent.

28-2.

(a) Error function (Scale = 0.0109, Shift = 460.94)

(b) Normal Distribution (Mean = 460.94, Standard Deviation = 64.78).

28-3.

(a) Uniform Distribution (Min = 302, Max = 496).

(b) Max Extreme Distribution (Mode = 62.01, Scale = 46.41, Shift = 301.99).

28-4.

	A	B	C	D	E	F	G	H	I
1							(all times in months)		
2							Start	Activity	Finish
3	Activity	Predecessor	Distribution	Parameters			Time	Time	Time
4	A Secure funding	—	Normal (mean, st. dev.)	6	1		0.0	6.257	6.3
5	B Design Building	A	Uniform (min, max)	6	10		6.3	9.188	15.4
6	C Site Preparation	A	Triangular (min, most likely, max)	1.5	2	2.5	6.3	1.661	7.9
7	D Foundation	B, C	Triangular (min, most likely, max)	1.5	2	3	15.4	2.219	17.7
8	E Framing	D	Triangular (min, most likely, max)	3	4	6	17.7	4.100	21.8
9	F Electrical	E	Triangular (min, most likely, max)	2	3	5	21.8	2.322	24.1
10	G Plumbing	E	Triangular (min, most likely, max)	3	4	5	21.8	3.514	25.3
11	H Walls and Roof	F, G	Triangular (min, most likely, max)	4	5	7	25.3	4.862	30.1
12	I Finish Work	H	Triangular (min, most likely, max)	5	6	7	30.1	6.000	36.1
13	J Landscaping	H	Fixed (5)				30.1	5	35.1
14									
15						Project Completion Time			35.140
16					Mean Project Completion Time				34.917

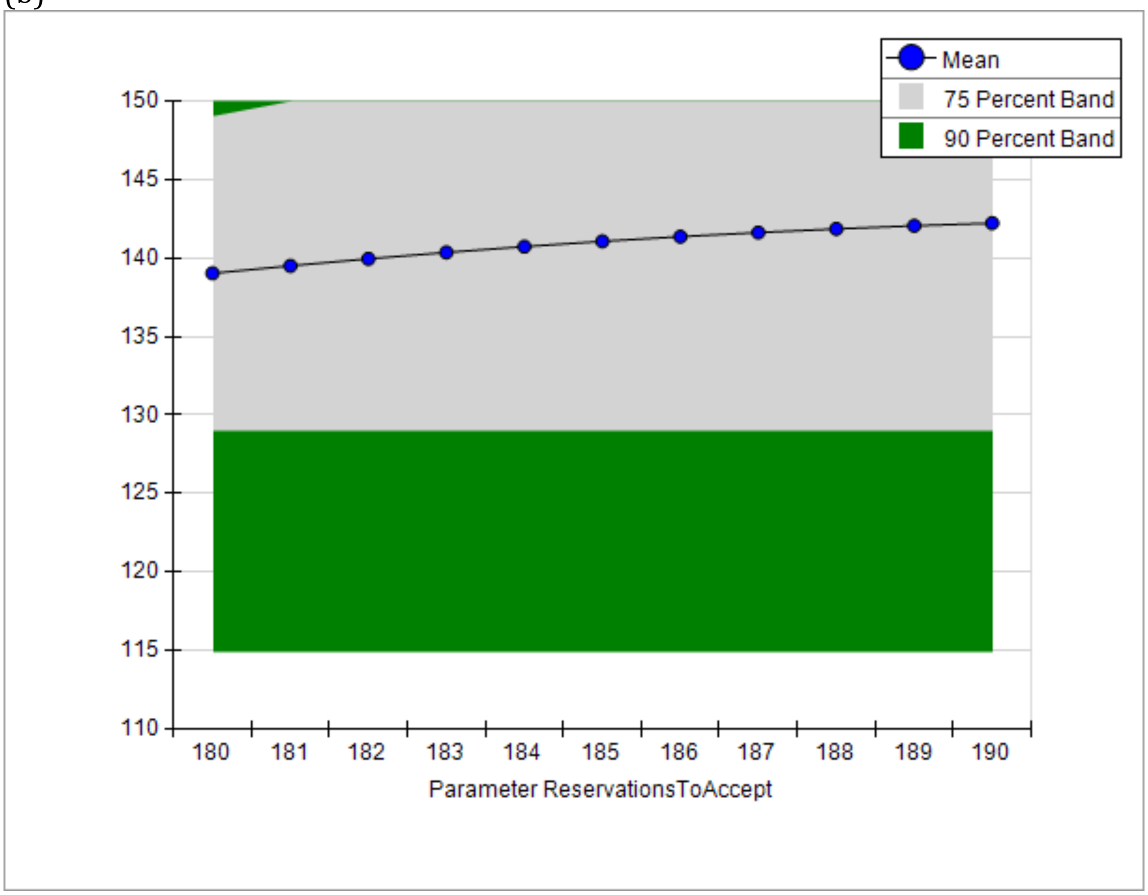
(a) The mean project completion time is approximately 35 months.

28-10.

(a) Accepting approximately 185 reservations maximizes the mean profit.

Reservations to Accept	Mean Profit
180	$11,612
181	$11,719
182	$11,806
183	$11,875
184	$11,918
185	$11,940
186	$11,936
187	$11,917
188	$11,875
189	$11,812
190	$11,732

(b)



(c) The optimal number of reservations to accept is approximately 185, as found by Solver.

	B	C	D	E	F
3		Data			
4	Available Seats	150			
5	Fixed Cost	$30,000			
6	Avg. Fare / Seat	$300			
7	Cost of Bumping	$450			
8					
9				Mean	Standard Dev.
10	Ticket Demand	161.58	*Normal*	195	30
11	Demand (rounded)	162			
12					
13	Reservations to Accept	185			
14					
15				Tickets	Probability
16				Purchased	to Show up
17	Number that Show	129	*Binomial*	162	80%
18					
19					
20	Number of Filled Seats	129		Ticket Revenue	$38,700
21	Number Denied Boarding	0		Bumping Cost	$0
22				Fixed Cost	$30,000
23	Mean Filled Seats	141.04		Profit	$8,700
24	Mean Denied Boarding	0.86			
25	Mean Profit	$11,925			