CASE: Merton Truck Company

Quantitative Techniques- II

Assignment: - 1

Section: - F

Group number 3

Submitted To:

Prof. Bhuvanesh Pareek

Submitted By:

Aseem Khattri

Smriti Jyoti

Syed Jibran Bukhari

Ambika Ratnoo

Harshvardhan Singh Sachdev

Vinit Dilip Patil

Rosemary Jose

Contribution Margin Analysis

	Model 101	Model 102
Direct Material	$ 24,000.00	$ 20,000.00
Direct Labor		
Engine assembly	$ 1,200.00	$ 2,400.00
Metal Stamping	$ 800.00	$ 600.00
Final Assembly	$ 2,000.00	$ 1,500.00
Total Direct Labor	$ 4,000.00	$ 4,500.00
Overheads		
Engine assembly	$ 2,100.00	$ 4,000.00
Metal Stamping	$ 2,400.00	$ 2,000.00
Final Assembly	$ 3,500.00	$ 2,500.00
Total Overheads	$ 8,000.00	$ 8,500.00
Total Variable Cost	$ 36,000.00	$ 33,000.00
Selling price per unit	$ 39,000.00	$ 38,000.00
Contribution Margin	$ 3,000.00	$ 5,000.00

Contribution Margin = Selling price per unit - Total Variable Cost per unit

Fixed Cost Analysis

<table>
<tr><td>Fixed Cost</td><td>Model 101</td><td>Model 102</td></tr>
<tr><td>Engine Assembly</td><td colspan="2">$1,700,000.00</td></tr>
<tr><td>Metal Stamping</td><td colspan="2">$2,700,000.00</td></tr>
<tr><td>Final Assembly</td><td>$2,700,000.00</td><td>$1,500,000.00</td></tr>
<tr><td>Total Fixed Cost</td><td colspan="2">$8,600,000.00</td></tr>
</table>

Therefore,

Profit = (Unit Contribution Margin of Model 101 Truck*number of units of Model 101 truck + Unit Contribution Margin of Model 102 truck*number of units of Model 102 truck) – Total Fixed Cost

1(a)

Let number of Model 101 Truck manufactured = x

Let number of Model 102 Truck manufactured = y

Objective Function: To maximize profit

Maximize	3000x	+	5000y		-	8600000	
Subject to	1x	+	2y	<=	4000	(Engine Assembly Constraint)	
	2x	+	2y	<=	6000	(Metal Stamping Constraint)	
	2x			<=	5000	(Model 101 Assembly Constraint)	
			3y	<=	3000	(Model 102 Assembly Constraint)	
	x			>=	0	(Non-negativity Constraint)	
			y	>=	0	(Non-negativity Constraint)	

Solving in Microsoft Excel using Simplex LP method:

Objective Cell (Max)

Cell	Name	Original Value	Final Value
$F$5	Profit	$ (8,600,000.00)	$ 2,400,000.00

Variable Cells

Cell	Name	Original Value	Final Value	Integer
$C$2	Model 101 Truck	0	2000	Contin
$C$3	Model 102 Truck	0	1000	Contin

Constraints

Cell	Name	Cell Value	Formula	Status	Slack
$G$10	Metal Stamping	6000	$G$10<=$I$10	Binding	0
$G$11	Model 101 Assembly	4000	$G$11<=$I$11	Not Binding	1000
$G$12	Model 102 Assembly	3000	$G$12<=$I$12	Not Binding	1500
$G$9	Engine Assembly	4000	$G$9<=$I$9	Binding	0

Sensitivity Analysis:

Variable Cells

Cell	Name	Final Value	Reduced Cost	Objective Coefficient	Allowable Increase	Allowable Decrease
$C$2	Model 101 Truck	2000	0	3000	2000	500

$C$3	Model 102 Truck	1000	0	5000	1000	2000

Constraints

Cell	Name	Final Value	Shadow Price	Constraint R.H. Side	Allowable Increase	Allowable Decrease
$G$10	Metal Stamping	6000	500	6000	500	1000
$G$11	Model 101 Assembly	4000	0	5000	1E+30	1000
$G$12	Model 102 Assembly	3000	0	4500	1E+30	1500
$G$9	Engine Assembly	4000	2000	4000	500	500

Therefore, best product mix for Merton is:

Model 101 trucks = 2000 units

Model 102 trucks = 1000 units

Variables		
Model 101	Model 102	objective: max Profit
2,000	1,000	$2,400,000.00

1(b)

Since, the engine assembly constraint is a binding one and have a shadow price of $2000.00. So, if Assembly capacity were raised by one unit from 4000 to 4001 then extra unit Engine assembly capacity is worth $2000.00

Therefore, new product mix will be:

Variables		
Model 101	Model 102	objective: max Profit
1999	1001	$2,402,000.00

1(c)

If capacity of engine assembly is increased to 4100.

Therefore, increase in profit due to 100 unit increase in production capacity

=$2600000 - $2400000

=$200000.00

The increase in profit is 100 times that in part (b).

New product mix will be:

Variables		
Model 101	Model 102	objective: max Profit
1900	1100	$2,600,000.00

1(d)

As seen from *Sensitivity analysis* table, allowable increase for engine assembly is 500 calculated below:

Finding the value of x and y using equation

$2x + 2y = 6000$

$3y = 4500$

We get x= 1500, y=1500

Substituting the value of x and y in the below equation,

$= 1x + 2y$

$= 1*(1500) + 2*(1500) = 4500$

Therefore, additional units can be added is (4500 – 4000 = 500).

New product mix:

Variables		
Model 101	Model 102	objective: max Profit
1500	1500	$3,400,000.00

2)

Increase in one unit of capacity increases the contribution by $ 2000. Company can use this alternative by renting 500 machine hours till which contribution increases after that there is no change in contribution of increased unit in capacity. Also company should be willing to pay $ 2000 for a rented machine hour.

New product mix:

Variables		
Model 101	Model 102	objective: max Profit
1500	1500	$3,400,000.00

3)

Let number of Model 101 Truck manufactured = x

Let number of Model 102 Truck manufactured = y

Let number of Model 103 Truck manufactured = z

Objective Function: To maximize profit

Maximize $3000x + 5000y + 2000z - 8600000$

Subject to

$1x + 2y + 0.8z <= 4000$ (Engine Assembly)

$2x + 2y + 1.5z <= 6000$ (Metal Stamping)

$2x + 1z <= 5000$ (Model 101 Assembly)

	3y		<=	3000	(Model 102 Assembly)
x			>=	0	(Non-negativity)
	y		>=	0	(Non-negativity)
		z	>=	0	(Non-negativity)

Objective Cell (Max)

Cell	Name	Original Value	Final Value
$F$5	Profit	$ 2,400,000.00	$ 2,400,000.00

Variable Cells

Cell	Name	Original Value	Final Value	Integer
$C$2	Model 101 Truck	2000	2000	Contin
$C$3	Model 102 Truck	1000	1000	Contin
$C$4	Model 103 truck	0	0	Contin

Constraints

Cell	Name	Cell Value	Formula	Status	Slack
$H$10	Metal Stamping	6000	$H$10<=$J$10	Binding	0
$H$11	Model 101 Assembly	4000	$H$11<=$J$11	Not Binding	1000
$H$12	Model 102 Assembly	3000	$H$12<=$J$12	Not Binding	1500
$H$9	Engine Assembly	4000	$H$9<=$J$9	Binding	0

Sensitivity Report:

Variable Cells

Cell	Name	Final Value	Reduced Cost	Objective Coefficient	Allowable Increase	Allowable Decrease
$C$2	Model 101 Truck	2000	0	3000	2000	500
$C$3	Model 102 Truck	1000	0	5000	1000	2000
$C$4	Model 103 truck	0	-350	2000	350	1E+30

Constraints

Cell	Name	Final Value	Shadow Price	Constraint R.H. Side	Allowable Increase	Allowable Decrease
$H$10	Metal Stamping	6000	500	6000	500	1000

$H$11	Model 101 Assembly	4000	0	5000	1E+30	1000
$H$12	Model 102 Assembly	3000	0	4500	1E+30	1500
$H$9	Engine Assembly	4000	2000	4000	500	500

(a)

As represented in above table, in order to maximize their profit Merton should not produce any 103 truck

(b)

Reduced cost for Model 103 is 350. This shows that the contribution of model 103 must be >= (2000+350) = 2350 to be worth to be produced.

4) From Sensitivity analysis it is clear that maximum 500 units of engine capacity can be added. Therefore, new constraint will be

1x + 2y <= 4500 (Engine Assembly Constraint)

Upon solving LP the product mix we get is:

Variables		
Model 101	Model 102	objective: max Profit
1500	1500	$3,400,000.00

New Contribution		3400000
Increase in fixed cost		750000
Increase in labor	=250*3600	900000
Labor cost saving	=500*1200	600000
Net Contribution		**2350000**

So, Additional Revenue is **-50000$.** Since, this is decreasing the objective function hence, Merton should **not** assemble engines on overtime.

5)

Let number of Model 101 Truck manufactured = x

Let number of Model 102 Truck manufactured = y

Objective Function: To maximize profit

Maximize 3000x + 5000y - 8600000

Subject to

1x + 2y <= 4000 (Engine Assembly Constraint)

2x + 2y <= 6000 (Metal Stamping Constraint)

2x			<=	5000	(Model 101 Assembly Constraint)
		3y	<=	3000	(Model 102 Assembly Constraint)
-x	+	3y	=	0	(Product Ratio Constraint)

Variable Cells

Cell	Name	Original Value	Final Value	Integer
$C$2	Model 101 Truck	2000	2250	Contin
$C$3	Model 102 Truck	1000	750	Contin

Constraints

Cell	Name	Cell Value	Formula	Status	Slack
$G$12	Product ratio constraint	0	$G$12=$I$12	Binding	0
$G$9	Metal Stamping	6000	$G$9<=$I$9	Binding	0
$G$10	Model 101 Assembly	4500	$G$10<=$I$10	Not Binding	500
$G$11	Model 102 Assembly	2250	$G$11<=$I$11	Not Binding	2250
$G$8	Engine Assembly	3750	$G$8<=$I$8	Not Binding	250

Sensitivity Report:

Variable Cells

Cell	Name	Final Value	Reduced Cost	Objective Coefficient	Allowable Increase	Allowable Decrease
$C$2	Model 101 Truck	2250	0	3000	1E+30	4666.666667
$C$3	Model 102 Truck	750	0	5000	1E+30	14000

Constraints

Cell	Name	Final Value	Shadow Price	Constraint R.H. Side	Allowable Increase	Allowable Decrease
$G$12	Product ratio constraint	0	500	0	1000	1000
$G$9	Metal Stamping	6000	1750	6000	400	6000
$G$10	Model 101 Assembly	4500	0	5000	1E+30	500
$G$11	Model 102 Assembly	2250	0	4500	1E+30	2250
$G$8	Engine Assembly	3750	0	4000	1E+30	250

Upon solving the LP the new product mix is:

Variables		
Model 101	Model 102	objective: max Profit
2250	750	$1,900,000.00