

# Constraint Theory

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# Constraint Theory

- Constraint Theory is everywhere.
  - Doors in your house,
  - On the roads you drive,
  - At the restaurant you eat,
  - And in the production system.
- Constraint Theory in the production system is what we must overcome to earn maximum amounts.

# Constraint Theory

- Here is the setup for our example company.
- We have three products, Best, Better, and Good.
- Each product has its own sales price, variable costs, machine hours, and units produced per machine hour.

Sales price per Best product:	\$30.00
Variable manufacturing costs per Best product:	\$12.00
Number of Best products per machine hour:	10
Maximum number of Best products sold:	14,000
Sales price per Better product:	\$12.00
Variable manufacturing costs per Better product:	\$6.00
Number of Better products per machine hour:	20
Maximum number of Better products sold:	7,000
Sales price per Good product:	\$8.00
Variable manufacturing costs per Good product:	\$3.00
Number of Good products per machine hour:	38
Maximum number of Good products sold:	45,000
Maximum number of machine hours:	2,000

# Constraint Theory

- There is also a maximum number of units that can be sold, and
- There is a maximum number of machine hours – 2,000.
- These are constraints we must address.

Sales price per Best product:	\$30.00
Variable manufacturing costs per Best product:	\$12.00
Number of Best products per machine hour:	10
Maximum number of Best products sold:	14,000
Sales price per Better product:	\$12.00
Variable manufacturing costs per Better product:	\$6.00
Number of Better products per machine hour:	20
Maximum number of Better products sold:	7,000
Sales price per Good product:	\$8.00
Variable manufacturing costs per Good product:	\$3.00
Number of Good products per machine hour:	38
Maximum number of Good products sold:	45,000
Maximum number of machine hours:	2,000

# Constraint Theory

- This table provides the income related values we need to make decisions.
- With contribution margin per unit and units per hour we can compute contribution margin per machine hour.

<b>Income Statement</b>	<b>Best Product:</b>	<b>Better Product:</b>	<b>Good Product:</b>
Sales price per unit:	\$30.00	\$12.00	\$8.00
Less: Variable manufacturing costs per unit:	\$12.00	\$6.00	\$3.00
Contribution margin per unit:	\$18.00	\$6.00	\$5.00
Number of units per machine hour:	10.00	20.00	38.00
Contribution margin per machine hour:	\$180.00	\$120.00	\$190.00
Available machine hours:	2,000.00	2,000.00	2,000.00
Contribution margin at full capacity:	\$360,000.00	\$240,000.00	\$380,000.00
Quantity produced at full capacity:	20,000.00	40,000.00	76,000.00

# Constraint Theory

- Best has a contribution margin of \$180 per machine hour.
- Better has a CM of \$120 per machine hour.
- Good has a CM of \$190 per machine hour.
- Therefore Good is a GREAT product.

<b>Income Statement</b>	<b>Best Product:</b>	<b>Better Product:</b>	<b>Good Product:</b>
Sales price per unit:	\$30.00	\$12.00	\$8.00
Less: Variable manufacturing costs per unit:	\$12.00	\$6.00	\$3.00
Contribution margin per unit:	\$18.00	\$6.00	\$5.00
Number of units per machine hour:	10.00	20.00	38.00
Contribution margin per machine hour:	\$180.00	\$120.00	\$190.00
Available machine hours:	2,000.00	2,000.00	2,000.00
Contribution margin at full capacity:	\$360,000.00	\$240,000.00	\$380,000.00
Quantity produced at full capacity:	20,000.00	40,000.00	76,000.00

# Constraint Theory

- As great as Good is, we can produce 76,000 units and only sell 45,000.
- Another constraint.
- So we produce the maximum number of Goods, 45,000, and produce something else.

<b>Income Statement</b>	<b>Best Product:</b>	<b>Better Product:</b>	<b>Good Product:</b>
Sales price per unit:	\$30.00	\$12.00	\$8.00
Less: Variable manufacturing costs per unit:	\$12.00	\$6.00	\$3.00
Contribution margin per unit:	\$18.00	\$6.00	\$5.00
Number of units per machine hour:	10.00	20.00	38.00
Contribution margin per machine hour:	\$180.00	\$120.00	\$190.00
Available machine hours:	2,000.00	2,000.00	2,000.00
Contribution margin at full capacity:	\$360,000.00	\$240,000.00	\$380,000.00
Quantity produced at full capacity:	20,000.00	40,000.00	76,000.00

# Constraint Theory

- Some basic math tells us that producing 45,000 units of Good should take (45,000 units ÷ 38 units per hour consumes 1,184.21 hours.
- So we still have (2,000 hours – 1,184.21 hours) 815.79 hours available to manufacturing.

<b>Income Statement Per Item:</b>	<b>Best Product:</b>	<b>Better Product:</b>	<b>Good Product:</b>
Sales price per unit:			\$8.00
Less: Variable manufacturing costs:			\$3.00
Contribution margin per unit:			\$5.00
Number of units per machine hour:			38.00
Contribution margin per machine hour:			\$190.00
Machine hours utilized:			1,184.21
Contribution margin at utilized capacity:			\$225,000.00
Quantity produced at utilized capacity:			45,000.00



# Constraint Theory

- Since Best has a contribution margin of \$180 and Better has a CM of \$120 per hour, the choice is Best goes first.
- New constraint 2,000 hours available, using 1,184.21 hours for Good so we have 815.79 hours.
- Manufacturing can produce 10 units of Best per hour so the maximum produced would be 8,157.89, rounded down to 8,157.

# Constraint Theory

- Rounding down because, unless we are a very small portion of manufacturing, we can only sell whole units and we cannot exceed the constraint of 2,000 manufacturing hours.

# Constraint Theory

- So we produce 8,157 units of Best consuming just under the remaining 815.79 hours.
- This consumes our total 2,000 hours so we do not produce any Better units.

<b>Income Statement Per Item:</b>	<b>Best Product:</b>	<b>Better Product:</b>	<b>Good Product:</b>
Sales price per unit:	\$30.00	\$12.00	\$8.00
Less: Variable manufacturing costs:	\$12.00	\$6.00	\$3.00
Contribution margin per unit:	\$18.00	\$6.00	\$5.00
Number of units per machine hour:	10.00	20.00	38.00
Contribution margin per machine hour:	\$180.00	\$120.00	\$190.00
Machine hours utilized:	815.79		1,184.21
Contribution margin at utilized capacity:	\$146,842.11	\$0.00	\$225,000.00
Quantity produced at utilized capacity:	8,157.00	0.00	45,000.00

# Constraint Theory

- So, what is the benefit of this work for production?
- Best has a contribution margin of \$146,826 and Good has a contribution margin of \$225,000 for a total of \$371,826.

<b>Income Statement - Extended:</b>	<b>Best Product:</b>	<b>Better Product:</b>	<b>Good Product:</b>
Sales revenues:	\$244,710.00	\$0.00	\$360,000.00
Less: Variable manufacturing costs:	\$97,884.00	\$0.00	\$135,000.00
Contribution margin:	\$146,826.00	\$0.00	\$225,000.00

# Constraint Theory

- Why use Constraint Theory and think through the problem?
- Best has the highest unit contribution margin at  $(\$30 - \$12) \$18$ , Better has the next best CM at  $(\$12 - \$6) \$6$ , and Good had the worst at  $(\$8 - \$3) \$5$  per unit.
- Logic would go with Best followed by Better, ending in Good if time is available.

# Constraint Theory

- If we had done Best, Better, and Good in order we would have this for a basic income statement, \$341,500 as contribution margin.

<b>Income Statement - Extended:</b>	<b>Best Product:</b>	<b>Better Product:</b>	<b>Good Product:</b>		
Sales revenues:	\$420,000.00	\$84,000.00	\$76,000.00		
Less: Variable manufacturing costs:	\$168,000.00	\$42,000.00	\$28,500.00		
<b>Contribution margin:</b>	<b>\$252,000.00</b>	<b>\$42,000.00</b>	<b>\$47,500.00</b>	<b>\$341,500.00</b>	

- With Good followed by Best we have \$371,826.

<b>Income Statement - Extended:</b>	<b>Best Product:</b>	<b>Better Product:</b>	<b>Good Product:</b>		
Sales revenues:	\$244,710.00	\$0.00	\$360,000.00		
Less: Variable manufacturing costs:	\$97,884.00	\$0.00	\$135,000.00		
<b>Contribution margin:</b>	<b>\$146,826.00</b>	<b>\$0.00</b>	<b>\$225,000.00</b>	<b>\$371,826.00</b>	

# Constraint Theory

- By utilizing the Constraint Theory we maximized the benefit of the assets and minimized the constriction affect in production.
- The key remains, what can earn us the most per hour through production with consideration of what we can sell.

# Constraint Theory

The end.