

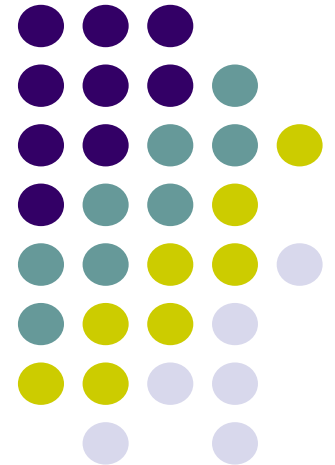


Goldratt
Implementation
Group

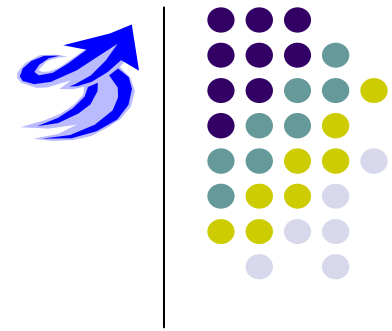
The Nature of Throughput and Bottlenecks

Originally developed by Eli Goldratt and
Mike Lilly

Presented by Ted Hutchin

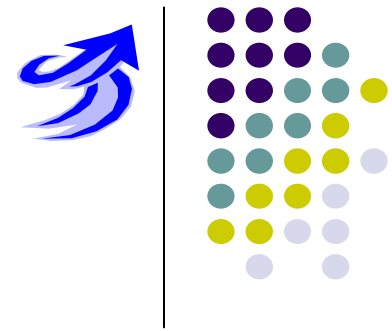


focus on essentials



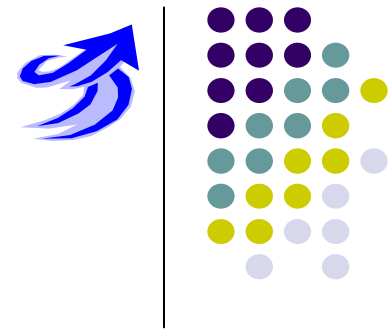
The Goal

- The main goal of a manufacturing company is to make money.
- All other goals are secondary.
- If you do not make money, you will not be in business much longer.



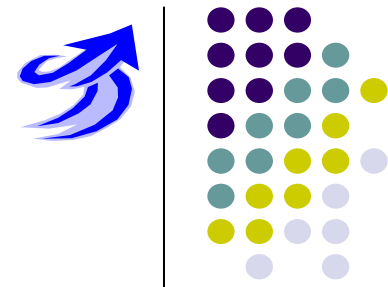
Continuous Improvement

- The main goal of a manufacturing company is to make more money today and yet more money tomorrow.



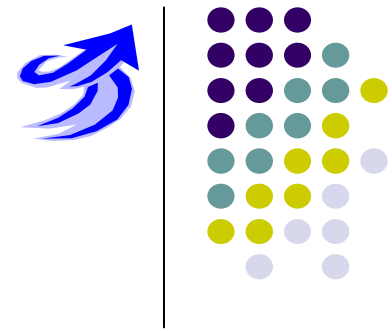
Measures

- We need measures to tell us how well we are doing in achieving the main goal.
- An old process control maxim:
 - “You can’t control what you can’t measure.”
- If the goal is to make money, the measure must relate to a unit of currency.



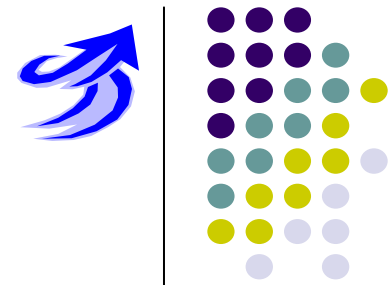
Common Measures

- PROFIT - The amount of money generated beyond what was spent in a time period.
- RETURN ON INVESTMENT (ROI) - The ratio of the PROFIT in a time period versus the amount of money invested in the company in order to generate that PROFIT.



A Drawback

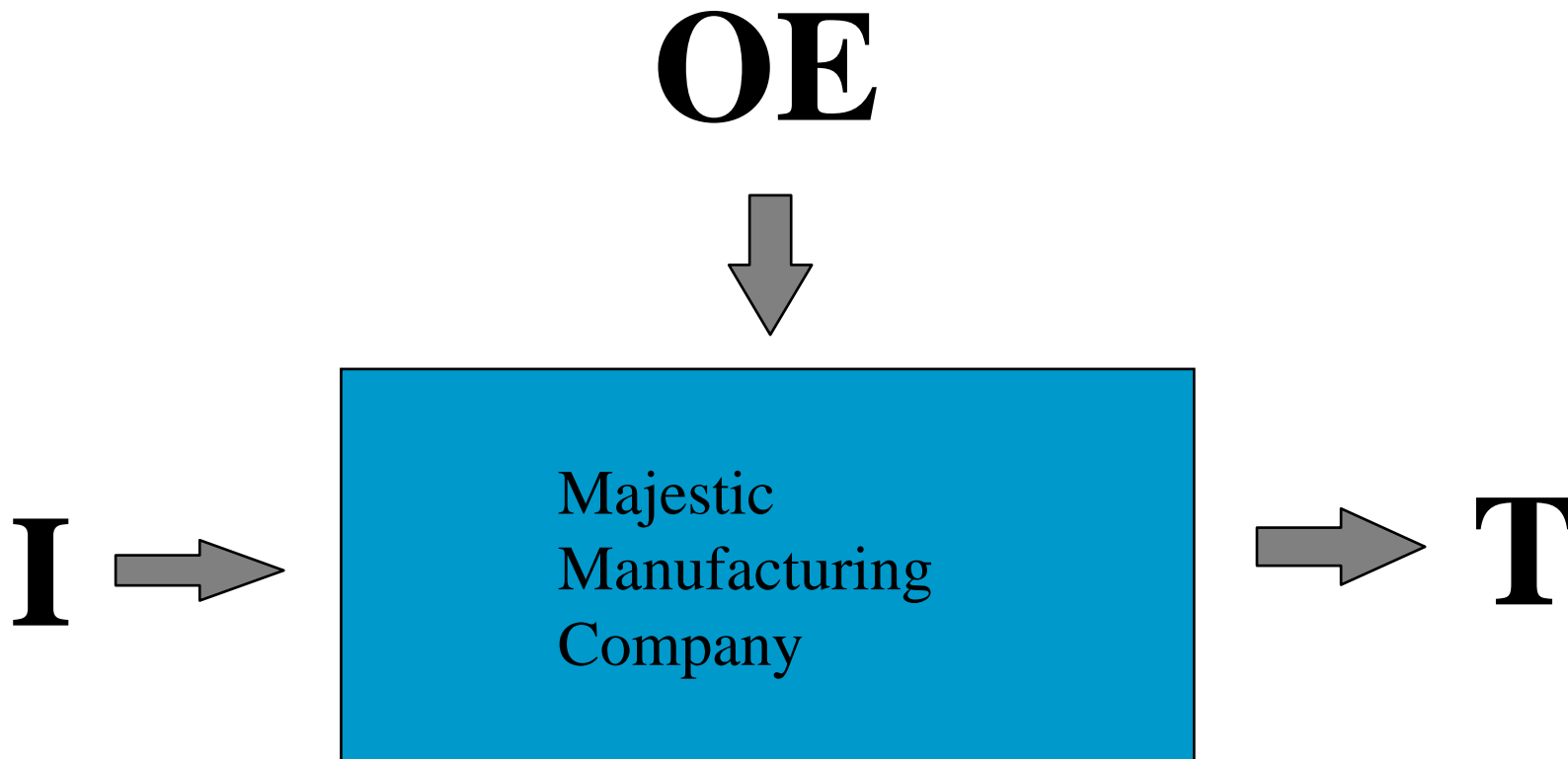
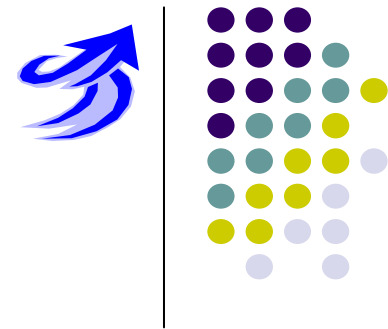
- Neither PROFIT nor ROI as measures are particularly helpful in determining the impact of production decisions.
- “If I decide to work overtime at that resource next week, what will it do to my PROFIT and ROI?”

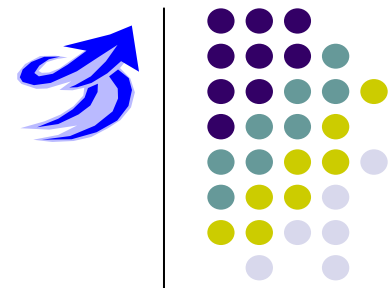


New Measures

- Throughput (T) - all the incoming money a company generates *through sales* (selling price - raw material - outside service)
- Inventory (I) - all the outgoing money that is *invested* in raw material, capital equipment, etc.
- Operating Expense (OE) - all the outgoing money that is *spent* on utilities, labor, etc.

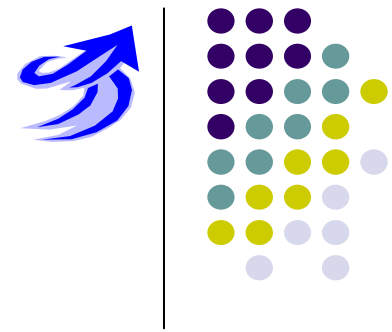
A Money Generating Machine





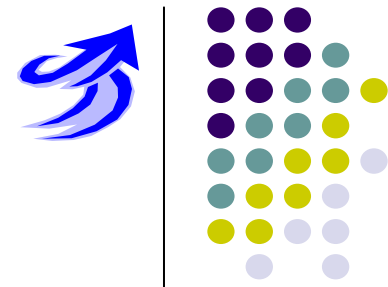
New measures relate to old

- PROFIT = $T - OE$
- ROI = $(T - OE) / I$
- *If we concentrated on improving just one measure to increase profit and ROI, we would want:*
 - Operating Expense(OE) to go
 - DOWN
 - Inventory(I) to go
 - DOWN
 - Throughput(T) to go
 - UP



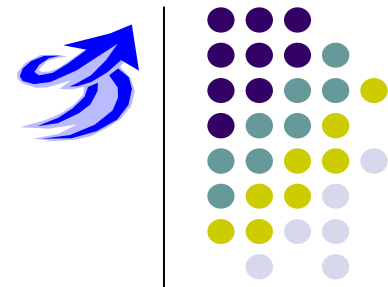
Limitations

- Of the three measures (T, I and OE), only THROUGHPUT can continually be moved in a direction that will result in increased PROFIT and ROI.
- Yet, when a company is not making enough money (or losing too much money) and a new leader is appointed, which measure is typically targeted for change?
- Operating Expense



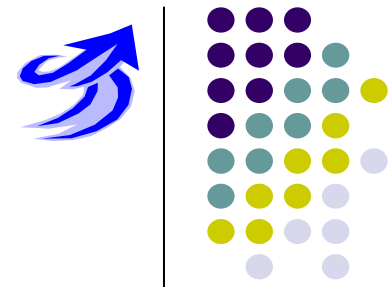
Today's Reality

- It is easier in the short term to cut operating expense than to increase throughput.
- Throughput is the result of everyone in the company working together to successfully deliver a quality product on time that some one is willing to pay for.
- It is easier to “point and shoot” than to get everyone working together more successfully.



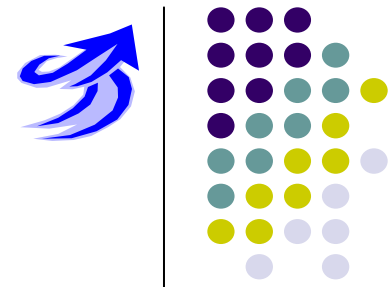
Long Term Thinking

- Cost-cutting is only a short-term tactical expediency.
- As a long term strategy, focusing on throughput is the best way to continually increase the profitability and health of a manufacturing company.



The Nature of Throughput

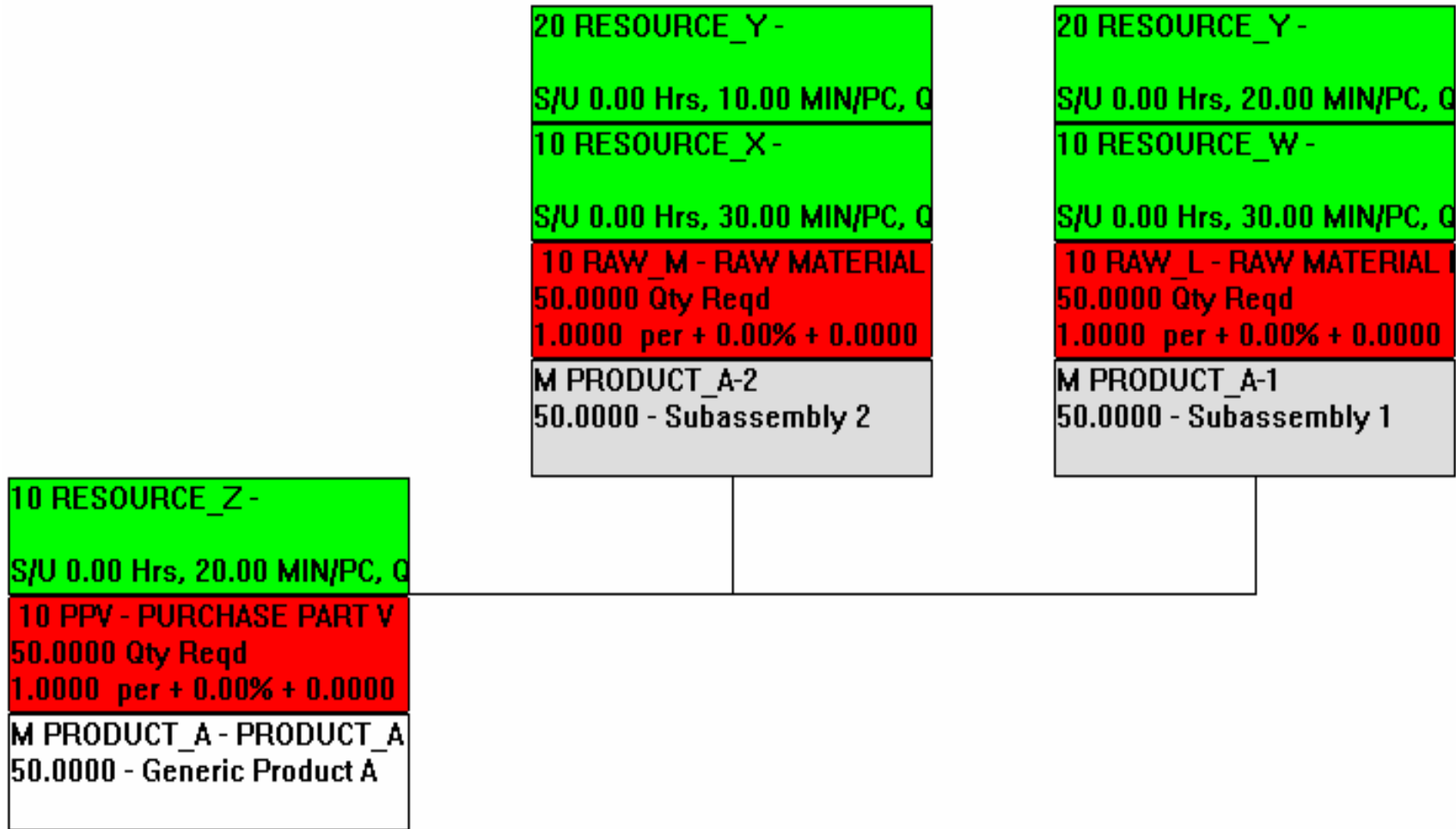
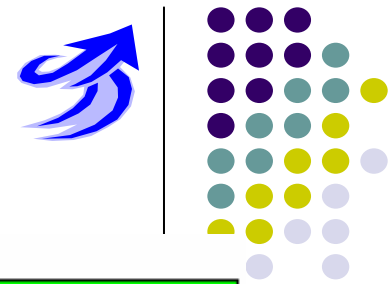
- Let's examine an example of a simple startup, Majestic Manufacturing Company (MMC):
 - MMC has 2 types of jobs/products it can make.
 - MMC has 4 resources: W, X, Y and Z
 - Each has 2400 minutes per week
 - MMC has weekly Operating Expense(OE) of £6000.
 - OE is considered constant, as we intend to get each worker 40 hours per week regardless of how much production work each will have.



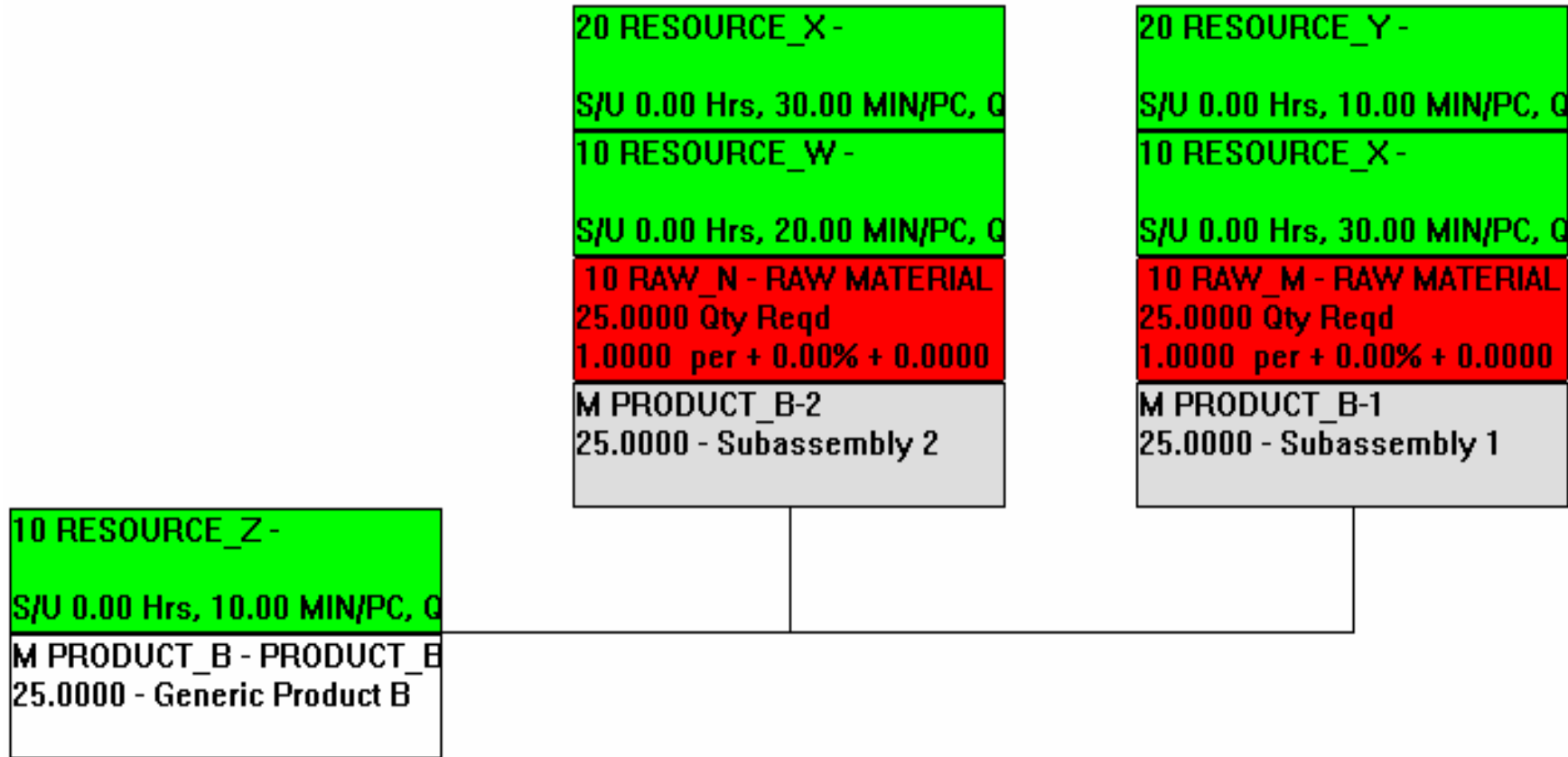
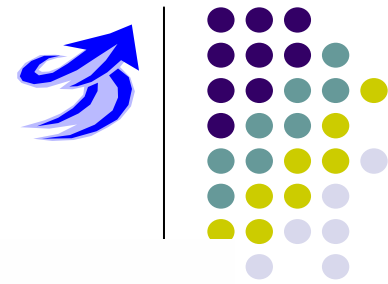
Our Market

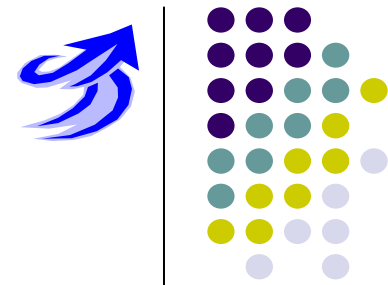
- MMC has potential to sell up to 50 units per week of PRODUCT_A at a selling price of £180.00 each
- MMC has potential to sell up to 25 units per week of PRODUCT_B at a selling price of £200.00 each

PRODUCT_A



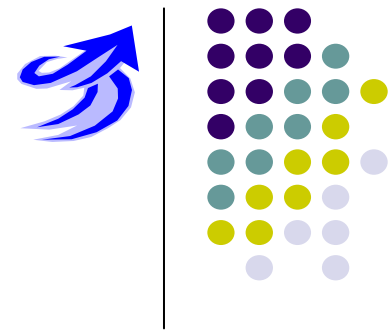
PRODUCT_B





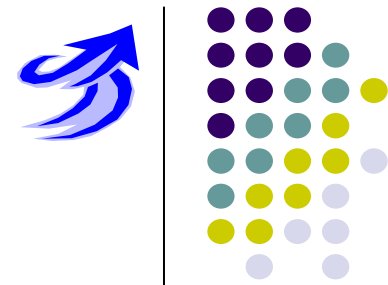
Material Costs

<u>Material</u>		
PPV	£25.00	EA
RAW_L	£30.00	EA
RAW_M	£35.00	EA
RAW_N	£45.00	EA



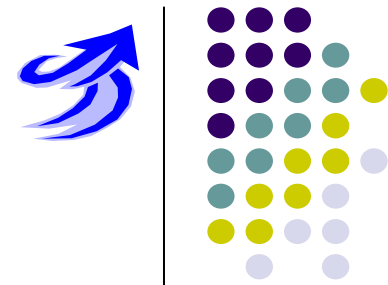
The Big Question

- How much PROFIT will MMC make in its first week of operation?
- Remember:
 - $\text{PROFIT} = T - \text{OE}$
 - $\text{OE} = \text{£}6000$ per week
- So the question becomes:
 - How much THROUGHPUT will MMC make in its first week of operation?



Calculating Throughput

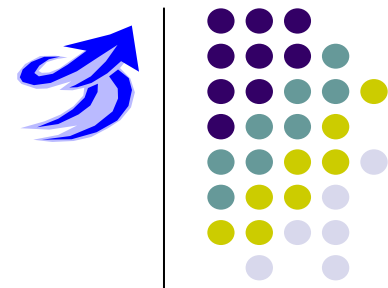
		<u>PRODUCT_A</u>	<u>PRODUCT_B</u>	
UNIT	Selling Price	£180.00	£200.00	
	Material	£90.00	£80.00	
	Throughput	£90.00	£120.00	
	Quantity	50.00	25.00	
TOTAL		£4,500.00	£3,000.00	<u>£7,500.00</u>



Calculating PROFIT

Throughput	£7,500.00
Operating Expense	£6,000.00
Profit	£1,500.00

- MMC will make £1500 of PROFIT *IF* MMC can make 50 of PRODUCT_A and 25 of PRODUCT_B in its first week of operation

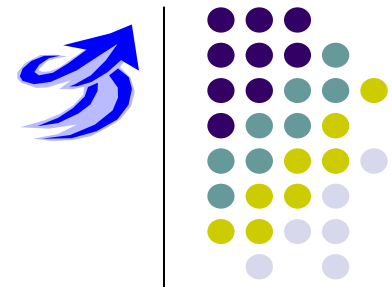


Can We Do It?

	Minutes @ RESOURCE_W	Minutes @ RESOURCE_X	Minutes @ RESOURCE_Y	Minutes @ RESOURCE_Z
50 of PRODUCT_A	1500	1500	1500	1000
25 of PRODUCT_B	500	1500	250	250
Total	2000	3000	1750	1250

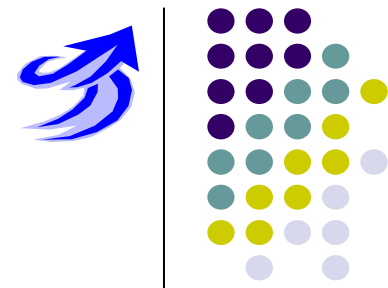
- We do not have enough of RESOURCE_X to make 50 of PRODUCT_A and 25 of PRODUCT_B

- RESOURCE_X is a BOTTLENECK



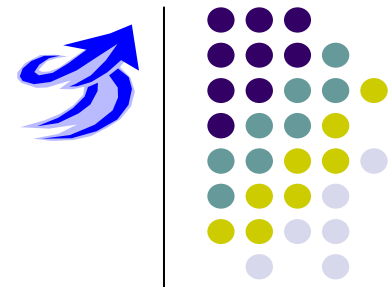
What Profit can MMC Make?

- If we cannot make £1500 in profit, what is the most we can make?
- Simple choice:
 - Make all of PRODUCT_A, then as much of PRODUCT_B as we can in the remaining time at RESOURCE_X.
 - Make all of PRODUCT_B, then as much of PRODUCT_A as we can in the remaining time at RESOURCE_X.



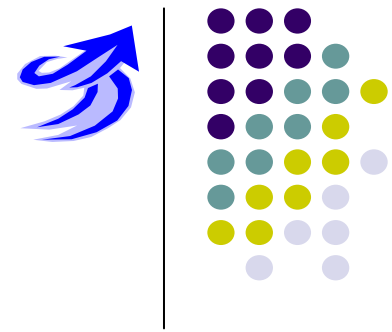
A Factorial Relationship

- Because we have only 2 types of jobs/products, we will need to test out only 2 combinations to find which will yield the highest profit.
- If we had 5 types of jobs or products, we would need to test out 120 ($1 \times 2 \times 3 \times 4 \times 5$) combinations.
- How many different types of jobs/products does your company make?
- We hope to find a calculation that will save us from having to try every possible combination.



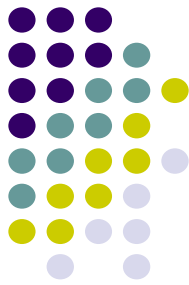
How to choose?

- We make more throughput on PRODUCT_B (£120) than we do on PRODUCT_A (£90).
- Examine GROSS PROFIT calculation:
 - Selling price minus:
 - Material
 - Outside Service
 - Labor
 - Overhead



Gross Profit Calculation

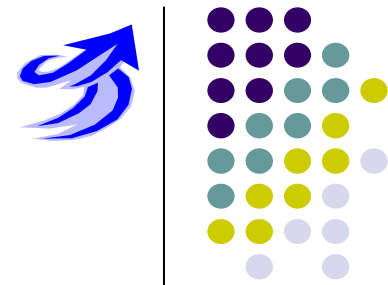
- We have 9600 total minutes of capacity (4 units X 2400 minutes each).
- As we pay £6000 for 9600 minutes, each minute can be valued at £0.625.
- It takes 110 minutes to make one PRODUCT_A and 100 minutes to make 1 PRODUCT_B.



Profit Margin Calculation

		<u>PRODUCT_A</u>	<u>PRODUCT_B</u>
	Minutes	110.00	100.00
UNIT	Selling Price	£180.00	£200.00
	Material	£90.00	£80.00
\$0.625 per minute	Labor & Overhead	£68.75	£62.50
	Unit Gross Profit	£21.25	£57.50

- Both Throughput and Profit Margin point to making all of PRODUCT_B first, then as much of PRODUCT_A as we have time left for at RESOURCE_X.

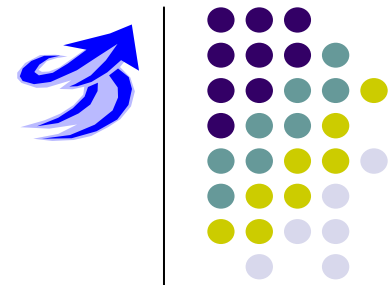


Making all of PRODUCT_B

	<u>PRODUCT_B</u>	<u>PRODUCT_A</u>	
Selling Price	£200.00	£180.00	
Material	£80.00	£90.00	
Throughput	£120.00	£90.00	
Quantity	25.00	30.00	
	£3,000.00	£2,700.00	<u>£5,700.00</u>

Throughput	£5,700.00
Operating Expense	£6,000.00
Profit	-£300.00

- We lose £300

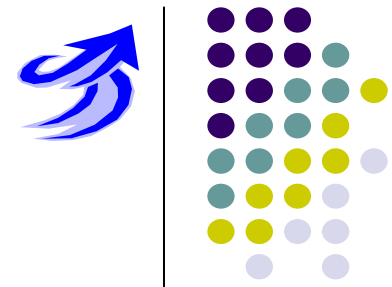


Making all of PRODUCT_A

	<u>PRODUCT_A</u>	<u>PRODUCT_B</u>	
Selling Price	£180.00	£200.00	
Material	£90.00	£80.00	
Throughput	£90.00	£120.00	
Quantity	50.00	15.00	
	£4,500.00	£1,800.00	<u>£6,300.00</u>

Throughput	£6,300.00
Operating Expense	£6,000.00
Profit	£300.00

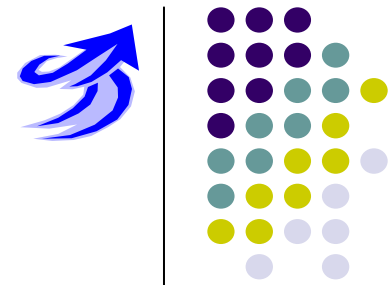
- *We make £300*



What Happened?

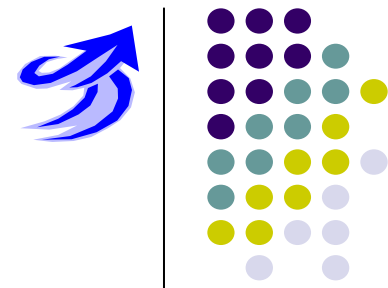
- Both Throughput and Profit Margin measurements pointed to making PRODUCT_B.
- Neither measure took into account the fact that RESOURCE_X is our bottleneck.

Taking Bottleneck into Account



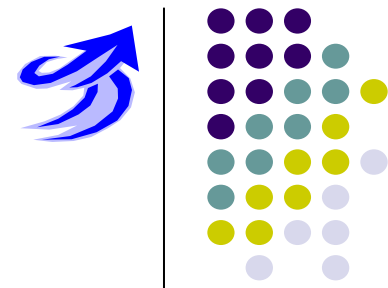
	<u>PRODUCT_A</u>	<u>PRODUCT_B</u>
Throughput	£90.00	£120.00
Minutes at RESOURCE_X	30.00	60.00
Throughput per min @ X	£3.00	£2.00

- Here is a measure that can be used on any number of jobs/products to determine which mix will yield the highest profit.



Bottleneck Barometer

- Knowledge of where the bottleneck is and where it will be in the future is a critical piece of information. It helps qualify decisions that can impact the company profit.
- “Throughput per bottleneck minute” can be used to judge the benefit of changes in the manufacturing process.
- Only by measuring the impact on throughput can you make optimal production decisions.



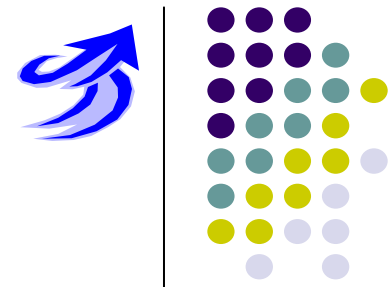
A Potential Improvement?

- Notice that Subassembly 2 of PRODUCT_A and Subassembly 1 of PRODUCT_B have a similar routing.

20 RESOURCE_Y - S/U 0.00 Hrs, 10.00 MIN/PC
10 RESOURCE_X - S/U 0.00 Hrs, 30.00 MIN/PC
10 RAW_M - RAW MATERI 50.0000 Qty Reqd 1.0000 per + 0.00% + 0.000
M PRODUCT_A-2 50.0000 - Subassembly 2

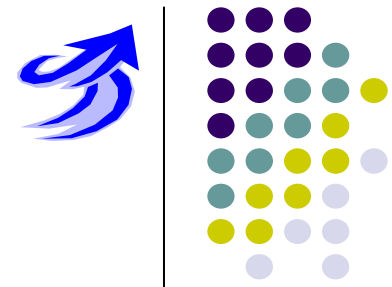
20 RESOURCE_Y - S/U 0.00 Hrs, 10.00 MIN/PC
10 RESOURCE_X - S/U 0.00 Hrs, 30.00 MIN/PC
10 RAW_M - RAW MATERI 25.0000 Qty Reqd 1.0000 per + 0.00% + 0.000
M PRODUCT_B-1 25.0000 - Subassembly 1

- What would you say if someone suggested they could reduce the time at operation 20 at RESOURCE_Y from 10 minutes to 5 minutes by buying a £300 tool?



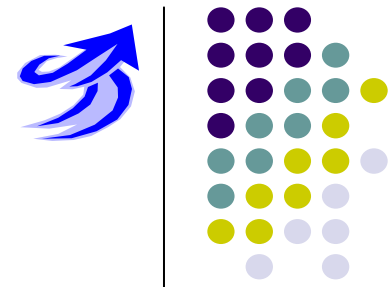
A Potential Improvement?

- By saving 5 minutes at RESOURCE_Y, we would reduce the cost of each unit of PRODUCT_A and PRODUCT_B by £3.125 (@ £0.625 per minute).
- Since we are planning on making 50 of PRODUCT_A and 15 of PRODUCT_B, we should save £203.125 ($£3.125 \times 65$) in the first week and recover our £300 cost in less than 2 weeks.



Not an Improvement at All

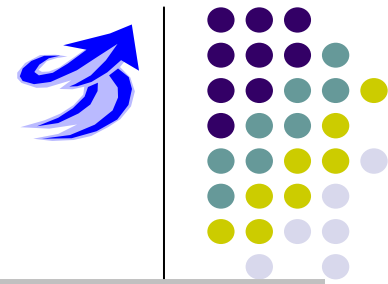
- Since “saving” 5 minutes at RESOURCE_Y neither reduces Operating Expense nor increases Throughput, it would not change the company profit. Buying the tool only wastes £300.
- Additionally, if we had rewarded the proposer we would be encouraging others to give us more such “wonderful” suggestions.



A Different Suggestion

- What if someone suggested they could reduce the time of Operation 10 at RESOURCE_X by 2 minutes but that it would increase the time of Operation 20 at RESOURCE_Y by 5 minutes?
- This would increase the total time to make each unit of PRODUCT_A and PRODUCT_B by 3 minutes, increasing the cost of each by £1.875.
- This would increase total cost per week by £121.875

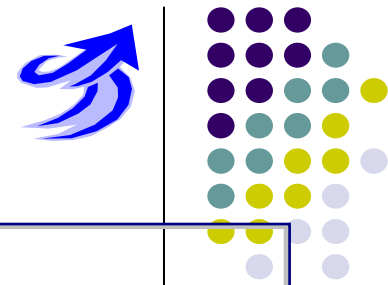
A Different Suggestion



	Minutes @ RESOURCE_W	Minutes @ RESOURCE_X	Minutes @ RESOURCE_Y	Minutes @ RESOURCE_Z
50 of PRODUCT_A	1500	1400	1750	1000
15 of PRODUCT_B	300	870	225	150
Total	1800	2270	1975	1150

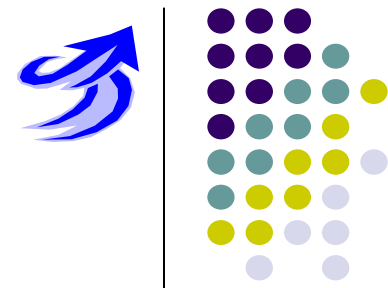
- Acting on the suggestion would get us 130 additional minutes at RESOURCE_X.
- We would still have available capacity at RESOURCE_Y.

A Definite Improvement



	<u>PRODUCT_A</u>	<u>PRODUCT_B</u>	
Selling Price	£180.00	£200.00	
Material	£90.00	£80.00	
Throughput	£90.00	£120.00	
Quantity	50.00	17.00	
	£4,500.00	£2,040.00	<u>£6,540.00</u>

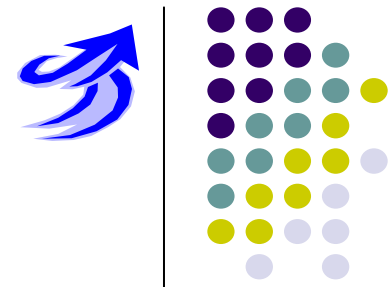
- Having 130 more minutes at RESOURCE_X, would allow us to make 2 extra units of PRODUCT_B, which means £240 of additional Throughput.



A Definite Improvement

Throughput	£6,540.00
Operating Expense	£6,000.00
Profit	£540.00

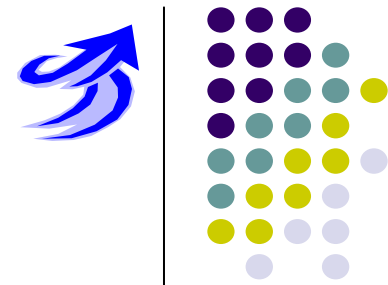
- Since we are making better use of existing capacity, Operating Expense did not change.
- Profit increases from £300 to £540, an 80% increase.



Market Segmentation

- Our existing market will buy up to 50 units per week of PRODUCT_A at a selling price of £180.00 each.
- What if we can find an additional customer who will buy them at £170.00 each?
- We could then sell 50 @ £180.00 and sell up to 30 more to the new customer, if we abandon our market for PRODUCT_B.

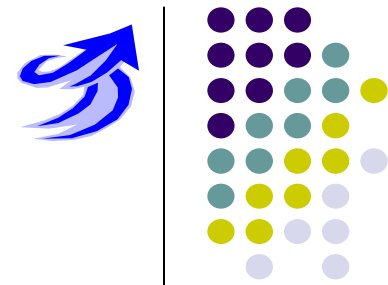
Market Segmentation



	<u>PRODUCT_A</u>	<u>Extra PRODUCT_A</u>	
Selling Price	£180.00	£170.00	
Material	£90.00	£90.00	
Throughput	£90.00	£80.00	
Quantity	50.00	30.00	
	£4,500.00	£2,400.00	<u>£6,900.00</u>

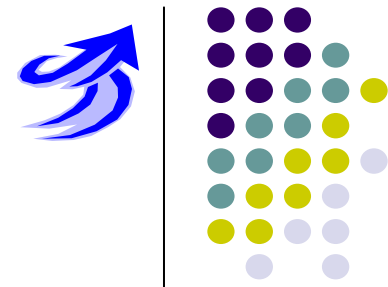
- Making 80 of PRODUCT_A and selling 50 at £180 and 30 at £170 would increase our profit from £300 to £900, a 300% increase.

Market Segmentation



Throughput	£90.00	£80.00
Minutes at X	30.00	30.00
Throughput per min @ X	£3.00	£2.67

- The additional units of PRODUCT_A would generate £2.67 of throughput per minute at RESOURCE_X while PRODUCT_B would have generated £2.00 per minute.



Review

- Throughput is a powerful measure of the contribution toward profit of a job or product.
- Knowing where the bottleneck is going to be is a powerful piece of information. It helps qualify decisions that can impact the company profit.
- “Throughput per bottleneck minute” is powerful because it tells us the relative contribution toward profit of a job or product.