

# Rethinking Manufacturing Performance

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# Agenda

- ◆ **Traditional Performance Measures**
- ◆ **The Goal of Business**
- ◆ **New Manufacturing Performance Measures**
- ◆ **Aligning Financial & Manufacturing Performance**
- ◆ **Measuring Manufacturing Performance**
- ◆ **Performance Improvement Methods**
- ◆ **Action Items**

This presentation is the original work of Michael Fricol based on ideas first published in *The Goal* by Eliyahu Goldratt and other derivative works.

# Traditional Manufacturing Performance Measures

- ◆ **Utilization**  
How intensively a Resource was used to produce a Product or Service.  
*Measures actual time used to available time.*
- ◆ **Efficiency**  
How well a Resource performed relative to an established Standard.  
*Measures actual output to standard output.*
- ◆ **Productivity**  
The Overall Ability for producing a Product or Service.  
*Measures Production Output versus Resource Input.*

# Traditional Performance Measures

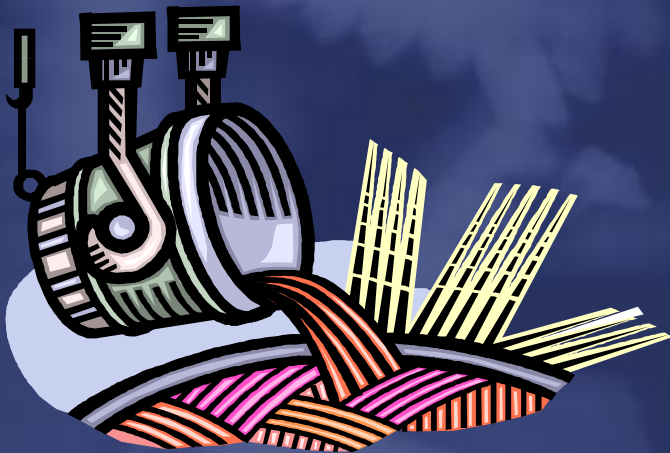
## *Utilization*

How intensively a Resource was used to produce a Product or Service.  
*Measures actual time used to available time.*

Available Time: 16 hours per day

Actual Time Used: 15 hours per day

Utilization = 93.75%



# Traditional Performance Measures

## *Utilization*

- ◆ Assume 3 machines with Utilization rates of:
  - A: 80%
  - B: 90%
  - C: 98%
- ◆ Assume Labor Utilization rates of:
  - 90% overall
  - Individual rates varying from 60% to 100%
- ◆ **Now that you know this, what do you really know about your Manufacturing Performance?**
- ◆ Common invalid perception that *Activity* is a real-time indicator of Utilization

# Traditional Performance Measures

## *Efficiency*

How well a Resource performed relative to an established Standard.

*Measures actual output to standard output.*

Standard Rate: 100 units per hour

Actual Rate: 740 units per 8 hour day

Efficiency = 92.5%



# Traditional Performance Measures

## *3 Common Efficiency Ratios*

- ◆ **Actual vs. Standard Units per time period**
  - Standard: 100 units per hour
  - Actual: 740 units per 8 hour day
  - Efficiency: 92.5% (740/800)
- ◆ **Dollar Volume Actual Output vs. Standard per time period**
  - Same as above, but measures Value of actual units produced vs. standard
  - Use for variability of unit value mix
    - Don't just produce easy, low value units
- ◆ **Standard Hours Produced vs. Actual Hours Worked**
  - Standard: 800 units per day
  - Actual: 8.5 hours to produce 800 units
  - Efficiency: 94.12% (8/8.5)

# **Traditional Performance Measures**

## ***Problems with Efficiency Ratios***

- ◆ **Establishing Standard Rates**
  - Who, when, what circumstances?
  - Does it reflect reality or the ideal or the average?
  - What does it represent?
- ◆ **Are Standard Rates Coordinated across multiple machines/work centers/cells?**
  - Work Center A has a Standard Rate of 80 units per hour
  - Work Center B has a Standard Rate of 100 units per hour
  - If B is downstream from A – can B achieve 100% efficiency?
  - If A is downstream from B – should B produce at 100%?
- ◆ **Parochial View of Performance**
  - My Work Center is running at 100% efficiency
  - No/Limited concern for what happens in other Work Centers

# Traditional Performance Measures

## *Productivity*

The Overall Ability for producing a Product or Service.  
*Measures Production Output versus Resource Input.*

Production Costs: \$5,000 per hour

Value of Output: \$6,000 per hour

Cost Productivity = 20%



# Traditional Performance Measures

## Productivity

- ◆ Many ways to measure Productivity
  - ◆ Is it meaningful?
  - ◆ Previous Page Example
    - 20% Cost Productivity
    - i.e. for every \$1 of Cost we Produce \$1.20 of Output Value
  - ◆ Commonly Measures output per employee
    - \$5m Revenue & 50 employees
    - Productivity = \$100,000 per employee
- But
- What about direct vs. indirect employees
  - What about costs to achieve productivity
  - What if we add more machines & reduce employees to 30?
    - Productivity moves to \$166,667 per employee
    - Is this better?
      - What if costs moved from \$4.5m to \$5.1m?

# Problems with Traditional Manufacturing Performance Measures

- ◆ **Measures what happened in the past**
- ◆ **Gives little or no indication for improvement**
  - Analysis of the irrelevant
  - Optimization of the insignificant
  - Trial and Error adjustments
- ◆ **Generally measures something related to output against a target**
  - Are the targets relevant overall and to each other?
  - Are the targets directly supportive of the overall target?
- ◆ **Questionable relevance to overall performance of:**
  - Producing the right output
  - In the right quantities
  - At the right time
  - Acceptable quality
  - At a price the customer is willing to pay

**“There is nothing so useless  
as doing efficiently that which  
should not be done at all.”**  
***Peter Drucker***

**Why are you in Business?**

**To MAKE MONEY!**

**The Underlying GOAL of any  
Business is to MAKE MONEY!**

# How does a Business Make Money?

- ◆ **Net Profit (NP)**
  - Revenues – Expenses
- ◆ **Return on Assets (ROA) or Return on Investment (ROI)**
  - Net Income / Assets Deployed
- ◆ **Cash Flow (CF)**
  - Cash Income – Cash Expenses
- ◆ **All 3 of the above measures must be Positive to Make Money**
- ◆ **Business Performance is Improving when all 3 measures are increasing simultaneously**

# How does Manufacturing Performance relate to Making Money

## Financial Measures that Really Matter

- Net Profit (NP)
- Return on Assets (ROA)
- Cash Flow (CF)



## A New Set of Manufacturing Performance Measures

- Throughput (T)
- Inventory (I)
- Operating Expense (OE)

# New Manufacturing Performance Measures

The 3 MFG Performance Measures that Really Matter  
*(If your overriding Goal is to Make Money)*

- ◆ Throughput (T)

The volume of **Money** generated by the Factory  
from **Sales**

Note: Output  $\neq$  Throughput

- ◆ Inventory (I)

The **Money** expended for Materials to fabricate  
Products to **Sell**

- ◆ Operating Expense (OE)

The **Money** the Factory spends to convert  
**Inventory into Throughput**

# The Relationship Between Manufacturing & Financial Performance (Example #1)

## Baseline

- ◆ Revenues: \$50m
- ◆ Direct Material (DM): \$20m  
(40% of revenue)
- ◆ Operating Expenses: \$26m
- ◆ Total Assets: \$30m
  - Inventory OH: \$10m  
(included)

## Financial Measures

- ◆ NP: \$4m
- ◆ ROA: 13.33%
- ◆ CF: \$4.5m  
(EBITDA)  
(Assume \$0.5m Amortization)

## Mfg Performance Improvements

- ◆ **Throughput: +5%**
- ◆ Inventory: unchanged
- ◆ Operating Expense: unchanged

## Results in

- ◆ Revenues Increase to \$52.5m
- ◆ DM Increases by \$1m  
(40% FG Material Content)

## Financial Measures

- ◆ **NP: \$5.5m (37.5% Increase)**
- ◆ **ROA: 18.33% (37.5% Increase)**
- ◆ **CF: \$6m (33.3% Increase)**

# The Relationship Between Manufacturing & Financial Performance (Example #2)

## Baseline (same as #1)

- ◆ Revenues: \$50m
- ◆ Direct Material (DM): \$20m  
(40% of revenue)
- ◆ Operating Expenses: \$26m
- ◆ Total Assets: \$30m
  - Inventory OH: \$10m  
(included)

## Financial Measures

- ◆ NP: \$4m
- ◆ ROA: 13.33%
- ◆ CF: \$4.5m  
(EBITDA)  
(Assume \$0.5m Amortization)

## Mfg Performance Improvements

- ◆ Throughput: unchanged
- ◆ **Inventory: -20%**

## Results in

- ◆ Assets Decrease to \$28m
- ◆ OE Decrease by \$0.5m  
(25% Carrying Cost X \$2m)

## Financial Measures

- ◆ **NP: \$4.5m (12.5% Increase)**
- ◆ **ROA: 16% (20% Increase)**
- ◆ **CF: \$7m (55.6% Increase in first year, 11% in year 2)**  
( $\$2m I + \$0.5m OE \text{ decrease}$ )

# The Relationship Between Manufacturing & Financial Performance (Example #3)

## Baseline (same as #1)

- ◆ Revenues: \$50m
- ◆ Direct Material (DM): \$20m  
(40% of revenue)
- ◆ Operating Expenses: \$26m
- ◆ Total Assets: \$30m
  - Inventory OH: \$10m

## Financial Measures

- ◆ NP: \$4m
- ◆ ROA: 13.33%
- ◆ CF: \$4.5m  
(EBITDA)  
(Assume \$0.5m Amortization)

## Mfg Performance Improvements

- ◆ **Throughput: +5%**
- ◆ **Inventory: -20%**

## Results in

- ◆ Revenues increase to \$52.5m
- ◆ Assets Decrease to \$28m
- ◆ OE Decrease by \$0.5m
- ◆ DM Increases by \$1m

## Financial Measures

- ◆ **NP: \$6m (50% Increase)**
- ◆ **ROA: 21.43% (61% Increase)**
- ◆ **CF: \$8.5m (89% Increase in first year, 44.4% in year 2)**

# The Old & New

- ◆ **Question your Performance Measures**
  - Do they Really Improve what ultimately matters?
    - NP
    - ROA
    - CF
- ◆ **Activity  $\neq$  Utilization  $\neq$  Throughput**
- ◆ **Productivity  $\neq$  Throughput**
- ◆ **Efficiency  $\neq$  Throughput**
- ◆ **How do Utilization and/or Efficiency Improvements effect?**
  - T
  - I
  - OE
- ◆ **Production Inventory is an Expense not an Asset**

**“Tell me how you measure my performance and I will tell you how I will behave.”**

# Measuring Manufacturing Performance Improvement

Always ask these 3 questions:

- ◆ Was more product shipped?
  - Increase T
- ◆ Was Inventory reduced?
  - Decrease I
- ◆ Were Expenses reduced?
  - Decrease OE

Unless 1 or more of these happen, there is no real performance improvement.

If any of these occur, then NP, ROA & CF will increase.

Goal is for all 3 to improve simultaneously

# Measuring Throughput

## *3 Data Points Required*

- ◆ **Shipments against Customer Demand (Sales)**
  - Gross Throughput
- ◆ **Returns**
  - $\text{Gross Throughput} - \text{Returns} = \text{Net Throughput}$
- ◆ **Demand (Sales Orders) by Ship Date**
  - Ship Date is factory ship to meet Customer Due Date

# Measuring Throughput

## *4 Categories to Measure*

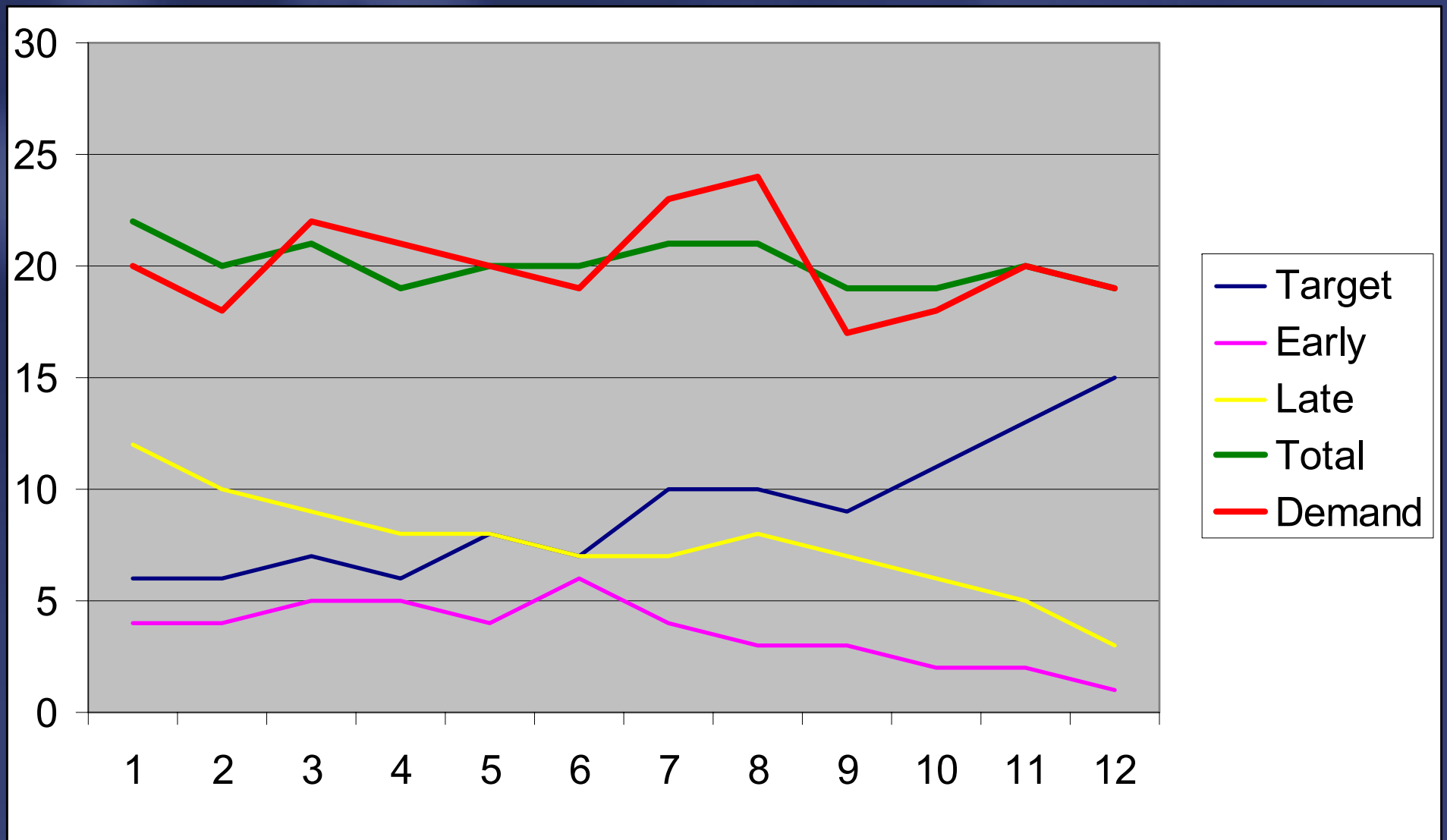
- ◆ **Target Throughput**
  - Net Throughput in a Period for Demand scheduled to ship in that period
- ◆ **Early Throughput**
  - Net Throughput in a Period shipped earlier than Demand ship date
- ◆ **Late Throughput**
  - Net Throughput in a Period shipped later than Demand ship date
- ◆ **Total Throughput**
  - Sum of Target, Early & Late

# Measuring Throughput

## *Considerations & Suggestions*

- ◆ **Early Throughput is as bad as Late**
- ◆ **Goal is 100% Target Throughput**
  - Target Throughput  $\approx$  Customer Service Level
  - 100% may not be economically feasible
- ◆ **Collect Data at most granular level**
  - Aggregate into Time Periods
  - Decrease Size of Time Periods as Throughput Improves
- ◆ **Measure by Additional Dimensions**
  - Production Line
  - Product Family
  - ...
- ◆ **Plot Trend of Each Category/Dimension over Time**
  - Visual picture of progress

# Tracking Throughput Performance





# Why do you have Inventory?

# Measuring Inventory Performance

## *Data Points*

### ◆ Value of Inventory in a Period

- Raw Materials (RM)
  - Pre-production direct materials
- Work In Process (WIP)
  - Direct materials in production
- Finished Good (FG)
  - Production output but not yet Throughput
- Total Inventory (TI)

### ◆ Categories

- Grouping of Direct Materials for more granular data
- Similar physical, usage, value or other characteristic
- Large Grain initially, more granular over time
- For Example
  - 'Seals in WIP' or 'Model XY12 in FG', etc.

# Measuring Inventory Performance

## *Relating Inventory to Throughput*

### Example – Assumptions:

- ◆ Total Throughput
  - \$5m for period 12
- ◆ Inventory Value in Period 12
  - \$0.5m in RM
  - \$0.3m in WIP
  - \$1.0m in FG
- ◆ RM:Throughput Ratio = 0.1
  - $0.5 \div 5$
  - For every \$1 T we have 10¢ RM I
- ◆ WIP:Throughput Ratio = 0.06
  - $0.3 \div 5$
  - For every \$1 T we have 6¢ WIP I
- ◆ FG:Throughput Ratio = 0.2
  - $1.0 \div 5$
  - For every \$1 T we have 20¢ FG I
- ◆ TI:Throughput Ratio = 0.36
  - $1.8 \div 5$
  - For every \$1 T we have 36¢ Total Inventory
- ◆ Can be expressed as Ratio or %

# Measuring Inventory Performance *Considerations & Suggestions*

- ◆ **No Absolute 'Good' or 'Bad' Standard**
- ◆ **Relative to a Manufacturing Business circumstances**
- ◆ **Lower Ratios are Better**
- ◆ **Adding Categories provides more Granular focus**
- ◆ **Plot Trend over Time**
  
- ◆ **Track Inventory vs. Throughput effect**
  - **Decreasing Inventory improves these ratios**
  - **Increasing Throughput improves these ratios**
  - **Ideally, Improvement effect from Both**

# Measuring Operating Expense *Accounting Methods*

- ◆ **Full Absorption Costing / GAAP Accounting**
  - Common standard
  - Assigns all Production & Material Costs to Inventory
  - Inventory as an Asset
  - Production → Inventory → Revenue
- ◆ **Throughput Accounting**
  - Production & Material Costs are Expensed Immediately
    - Not assigned to Inventory
  - Inventory is an Expense
  - Production → Throughput  
    ↘ Expenses

# Measuring Operating Expense

## *GAAP vs. Throughput Accounting*

### *Illustrative Example #1*

#### ASSUMPTIONS

Sales	\$10,000,000
Production Output	\$11,000,000
Direct Materials	40% of FG
Production Costs	\$2,000,000
	(not totally variable – assume fixed)

#### GAAP

Revenue	\$10,000,000
COGS <sup>1</sup>	<u>5,820,000</u>
Gross Margin	4,180,000
Selling & GA	<u>3,000,000</u>
Operating Income	<u>1,180,000</u>
Value of Inventory Increases by	\$580,000 (400k Matl +180k Prodn)

#### THROUGHPUT ACCOUNTING

Throughput <sup>3</sup>	\$10,000,000
Direct Materials <sup>2</sup>	<u>4,400,000</u>
Throughput Margin	5,600,000
Operating Expense:	
Production	2,000,000
Selling & GA	<u>3,000,000</u>
Operating Income	<u>600,000</u>
(True Inventory & OE Consumption)	

<sup>1</sup> Direct material & production costs based on *sales*

<sup>2</sup> Based on production *output*

<sup>3</sup> Revenue  $\approx$  Throughput

# Measuring Operating Expense

## *GAAP vs. Throughput Accounting*

### *Illustrative Example #2*

#### ASSUMPTIONS

Sales	\$10,000,000
Production Output	\$9,000,000
Direct Materials	40% of FG
Production Costs	\$2,000,000
	(not totally variable – assume fixed)

#### GAAP

Revenue	\$10,000,000
COGS <sup>1</sup>	<u>6,180,000</u>
Gross Margin	3,820,000
Selling & GA	<u>3,000,000</u>
Operating Income	<u>820,000</u>
Value of Inventory Decreases by \$580,000 (400k Matl +180k Prodn)	

#### THROUGHPUT ACCOUNTING

Throughput <sup>3</sup>	\$10,000,000
Direct Materials <sup>2</sup>	<u>3,600,000</u>
Throughput Margin	6,400,000
Operating Expense:	
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(True Inventory & OE Consumption)	

<sup>1</sup> Direct material & production costs based on *sales*

<sup>2</sup> Based on production *output*

<sup>3</sup> Revenue  $\approx$  Throughput

# Key Methods for Manufacturing Performance Improvements

- ◆ **Lean Manufacturing**
  - Eliminate Waste
  - Simplified Business & Manufacturing Processes
  - Minimize Variability
- ◆ **Six Sigma**
  - Improve Quality
  - Reduce Defects
  - Reduce Process Output Variability
- ◆ **Theory of Constraints (TOC)**
  - Constraint Management
  - Balance Capacity
  - Minimize Dependencies
  - Minimize time between spending money to produce, and receiving money from selling goods & services.

# Do you have the Basis for Improving Manufacturing & Financial Performance?

- ◆ **Product Definitions**
  - Product/Item Catalog
  - Accurate Material & Resource usage
- ◆ **Planning**
  - Accurate plans of What, When How Many to make
  - Exceptions to the Plan
- ◆ **Execution**
  - Inventory Accuracy
  - Real Visibility of Demand (Customer Orders)
- ◆ **Management**
  - Consistent Performance Measurement at all levels
  - Establishing and Implementing Policies & Procedures
- ◆ **Accounting**
  - Accurate Value reflection of Manufacturing Activity
  - Financial & Management Accounting

# There are only 3 Key Performances Measures that ultimately matter

- ◆ Increased **Throughput (T)**
  - Was more product sold and shipped?
- ◆ Decreased **Inventory (I)**
  - Was Production Inventory reduced?
- ◆ Decreased **Operating Expense (OE)**
  - Was more revenue produced with less resources?

All 3 contribute to improved Financial Performance:

- Net Profit (NP)
- Return on Assets (ROA) or Return on Investment (ROI)
- Cash Flow (CF)

# References

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