

Rethinking Manufacturing Performance (Version 3)

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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 Fritchol 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

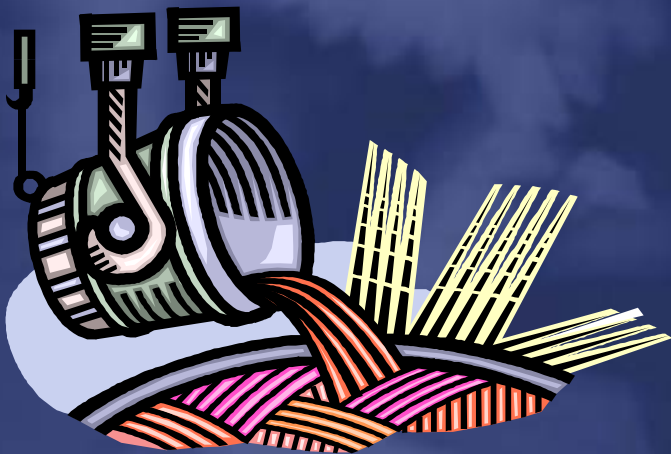
How intensively a Resource was used to produce a Product or Service.

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 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

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

◆ Throughput Accounting

- Production & Material Costs are Expensed Immediately
 - Not assigned to Inventory
- Inventory is an Expense

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 (not totally variable – assume fixed)	\$2,000,000

GAAP

Revenue	\$10,000,000
COGS ¹	<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 ³	\$10,000,000
Direct Materials ²	<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)	

¹ Direct material & production costs
based on *sales*

² Based on production *output*

³ 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 ¹	<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 ³	\$10,000,000
Direct Materials ²	<u>3,600,000</u>
Throughput Margin	6,400,000
Operating Expense:	
Production	2,000,000
Selling & GA	<u>3,000,000</u>
Operating Income	<u>1,400,000</u>
(True Inventory & OE Consumption)	

¹ Direct material & production costs based on *sales*

² Based on production *output*

³ 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**
 - 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)

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