



Performance Metrics

Module 10.5

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Presentation for:
ESD.60 – Lean/Six Sigma Systems
MIT Leaders for Manufacturing Program (LFM)
Summer 2004

These materials were developed as part of MIT's ESD.60 course on "Lean/Six Sigma Systems." In some cases, the materials were produced by the lead instructor, Joel Cutcher-Gershenfeld, and in some cases by student teams working with LFM alumni/ae. Where the materials were developed by student teams, additional inputs from the faculty and from the technical instructor, Chris Musso, are reflected in some of the text or in an appendix

Overview

- Learning Objectives
 - Understand how metrics drive behavior and performance
 - Understand the importance of aligning metrics with overall strategy
 - Understand basic differences between traditional and lean metrics
- Session Design (20-30 min.)
 - **Part I:** *Introduction and Learning Objectives (1-2 min.)*
 - **Part II:** *Lesson 1 and Exercise (3-5 min.)*
 - **Part III:** *Balanced Scorecard and Lesson 2 (3-5 min.)*
 - **Part IV:** Lesson 3. Differentiate output vs. throughput metrics (5-7 min.)
 - **Part V:** How does key Lean concepts apply to devising metrics (3-5 min.)
 - **Part VI:** “Disconnects,” (5-7 min.)



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Measure the Right Thing Exercise

- After LFM you take a position as a research analyst for Cost-Cutting Air (CCA), a new airline upstart. After running a Pareto Analysis (you are psyched to have the opportunity to use the tools you learned in your LFM Lean Class) you determine that **fuel consumption cost** is one of your highest controllable costs. You also know that pilots can minimize fuel consumption by taking measures such as turning off the air conditioning when passengers are not on the plane. This is clearly “**waste/muda**” **that can be eliminated...** and everyone knows that waste is not an option in a business where every cent counts. You want to impress your new boss, Jimmy Lean and show him how your b-school education really differentiates you from the other young motivated chaps. **What metrics might you recommend to encourage pilots to reduce costs?** How might you use this metric to reward CCA’s pilots?



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Metrics Drive Behavior

- Based off of a true story from Continental Airlines after bankruptcy in 1990's
- Cost cutting became the major company strategy
- Airline rewarded pilots for keeping fuel consumption low
 - Behavior - Pilots skimping on air conditioning and flying more slowly
 - Performance - Unhappy customers and behind schedule flights
 - Results - Valuable customers moved on to competitors

Lesson 1: "What gets measured gets done." Metrics drive behavior, both good and bad.



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Devising The Right Metrics

- A Metric system should be comprehensive and focus all business activities on customer requirements and organizational objectives
- Establishing a Balanced Scorecard
 - Define the Goals and Strategy ([Listen to the Customer](#))
 - Analyze strategy for “Critical Performance Variables” ([Understand the Job](#))
 - Link outcome and performance drivers measures ([Understand the interrelationships](#))
 - Work out how to measure its progress to the goals. ([Understand the cause-and-effect linkages](#))
- Applied at both Enterprise and Shop floor level



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- Balanced Scorecard is a set of financial and non financial measures that measures performance against all key stakeholder objectives
- The points in blue tries to simplify the balanced score card concept to shopfloor
 - Know your internal customers needs (next station in the line)
 - Understand what you can do in your job to serve them better
 - Devise metrics around it.

Amazon's Corporate Score-card

Key Goal: Make online shopping preferred mode for all types of goods

Fast and Free shipping for all types of products

- Customer
 - Failed Fast Track
 - Order cycle time mean and standard deviation
- Cost/Unit
 - Throughput per labor hour
 - Units shipped per labor hour
- Quality
 - Inventory Record Defect Rate
- Operations
 - Received and Shipped units and backlog
 - Ex (S&OP adherence)
- Safety
 - Lost Time Incidents and Rate
 - Record-able Incidents and Rate
- Other Financial and Vendor negotiation metrics

Lesson 2: Metrics must be holistic and align with the business strategy



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Scorecards can be applied for day to day operations as well

- Shop floor score cards
- Example of balance scorecard at shop floor: Amazon warehouse workers has to maintain both a good pickup time (orders picked from inventory) and cycle time per order and they both have opposing needs.

Throughput vs. Output Metrics

- Throughput metrics: Measures the amount of work done per unit time. Aimed at optimizing individual performance.
- Output Metrics: Measures the effectiveness in delivering required demand. Aimed at optimizing the flow across stations.
- Example:
 - Quality training: No. of students trained vs. Impact on job after training
 - Vantage Point in Value Stream (One man's throughput is another's output)
- Manufacturing Examples:
 - Availability Vs. OEE (Overall Equipment Effectiveness)
 - Overall production rate Vs. Build To Schedule



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Traditional vs. Lean Metrics

Complex, low volume assembly in aerospace

TRADITIONAL

- Jobs behind schedule metrics
 - Focus on accountability and individual performance
 - Assumes every job is equally important
 - Assumes individual efficiency drives overall performance
- Behavior using traditional metrics
 - Perform "easy" jobs first to improve metric (temporarily)
 - Out-of-sequence work
 - "I completed my work...why should I help someone else"
 - Focus on every problem

LEAN

- Flow metrics
 - Focus on global rather than local optimum
 - Assumes some jobs more critical than others
 - Assumes team drives overall performance
- Behavior using lean metrics
 - Work jobs in optimal sequence
 - Identify gaps in skills
 - Teamwork
 - Focus only on problems that impact overall performance



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Lean Metrics – An Example

Complex, low volume assembly in aerospace

Critical Chain	C1	C2				C3			C4
	Milestone 1	Milestone 2	Milestone 3	Milestone 4	Milestone 5	Milestone 6	Milestone 7	Milestone 8	Milestone 9
Feeder Chain			F1	F2	F3		F4	F5	
Unit 1	●	●	●	●	●	●	○	○	○
Unit 2	●	●	○	○	○	○	○	○	○
Unit 3	●	●	●	●	●	●	●	●	●
Unit 4	●	●	●	●	●	●	○	○	○

Reaction is necessary!

Should we react here?

Lean metrics help management make decisions....



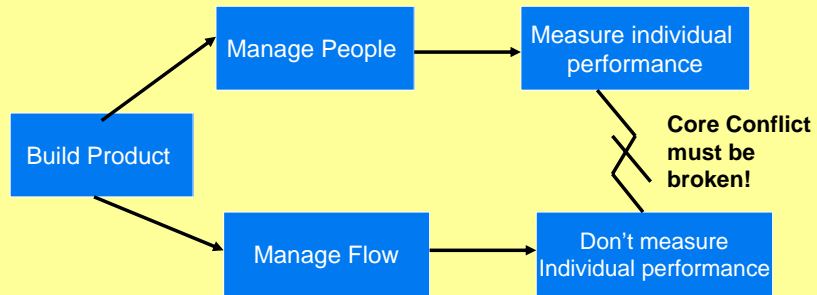
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This looks easy? Why doesn't everyone go lean?



Lesson 3: Lean metrics optimize global performance



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- Create lean teams and devise metrics for the team as opposed to individual

Lean Metrics - Characteristics

- Apply key lean concepts to metrics
 - Customer Focused
 - Holistic Metrics aligned with Strategy
 - Eliminate Waste to Create Value
 - Throughput vs. Output measures
 - Done at All levels in the organization
 - Communication and Buy-in
 - Continuous Improvement
 - Re- Assessment and Results



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•Points three and four are equally important. Covered in the backup slides to some extent.

Disconnects

➤ Technical Factors

- Reliable and consistent metrics
- Vertical and horizontal alignment
- Adequate resource commitment
- Relevancy of metrics over time

➤ Social Factors

- Learning vs. Reporting
- Acceptance of measures
- Overcoming inertia
- Misuse, manipulation, and gaming
 - Corporate values becomes important here
 - Culture and integrity indispensable to success.
- Right incentives for performance



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Reliable Metrics : Accurate, Actionable and Timely

Consistent Metrics

Avoid confusing requirements and expectations internal and external - Balanced Score card

Vertical and Horizontal alignment

“Catchball” process to deploy metrics to all levels.

Adequate Resource commitment

Manpower, Money, Facilities and Training

Evaluate relevancy over time

Life Cycle management for metrics

Learning vs reporting

Process indicators as diagnostic data, but do not optimize the system to these measures.

Acceptance of measures

Don't know why

Don't know how metrics fit into big picture (correlation to end result)

Overcome Inertia

Accountability issues

Metrics are mis used, manipulated, and gamed

They can be manipulated and used to justify present processes

Right Incentives for performance

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Appendix: Instructor's Comments and Class Discussion on 10.5

- Metrics must be assigned a level of priority
 - Some are necessary but insufficient, others are strictly performance-based
- In continuous improvement situation, metrics will get tighter over time
 - First metrics should deal with stability, second metrics should deal with flow
- *Metrics are only one factor in organizational behavior.* Other important factors:
 - Character of employees
 - Leadership styles of managers
 - Organizational rewards and incentives
 - Organizational culture: what behavior gets people promoted

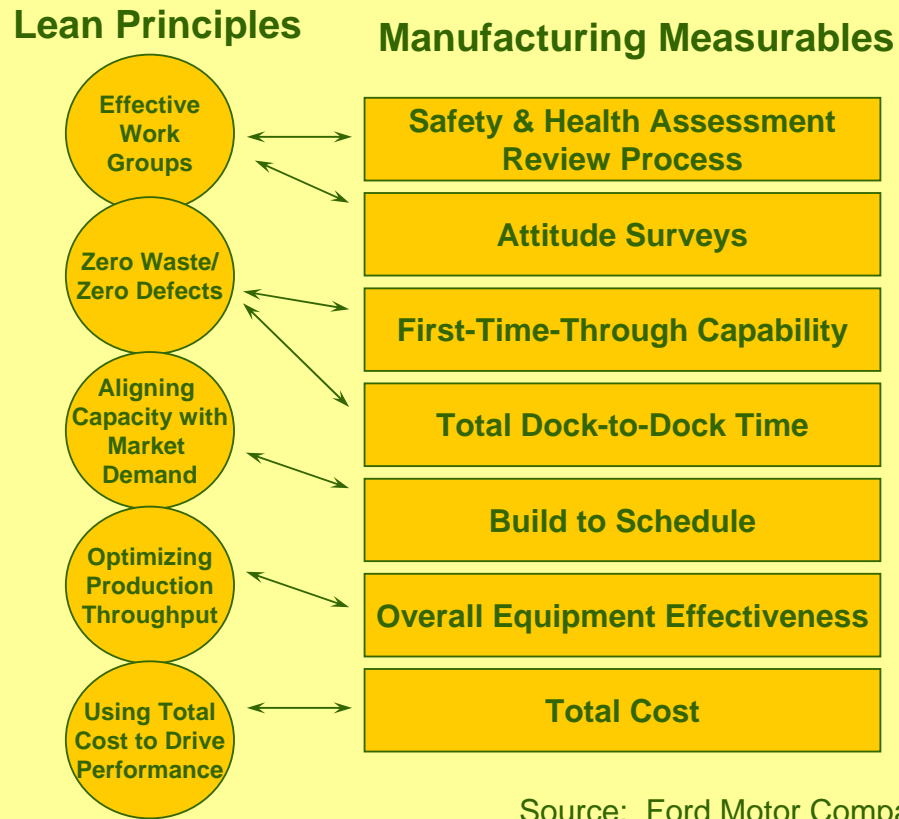


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Linking Lean Principles and Manufacturing Measurables



Source: Ford Motor Company

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Source: Ford Motor Company

Build To Schedule -- What is it?

➤ ***In Plain Words:***

➤ A way of knowing if you built the right parts, in the right quantity, in the right order

➤ ***A Formal Definition:***

➤ Percent of units scheduled for a given day that are built on the correct day, in the correct quantity and correct mix

BTS =

Volume x Mix x Sequence



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Build To Schedule -- Why use it?

➤ **Lean Principle:**

- Aligning Capacity with Market Demand

➤ **BTS can help. . .**

- Keep changes in volume or mix from swamping or starving departments upstream or downstream
- Operate with smaller “floats” -- which increases the need to track BTS
- Respond to customer demand for “in-line vehicle sequencing” -
- which requires BTS



Sample Lessons from Build To Schedule Data -- Volume

Overbuilding here -- probably done to achieve central performance goals; probably used up more float than expected from feeder departments

No credit for more than 100%

Volume Performance			
Week of:	Pieces Scheduled	Pieces Produced	%
6/2/99	14,650	16,303	100%
6/9/99	16,990	17,317	100%
6/16/99	16,380	15,755	96.18%



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Sample Lessons from Build To Schedule Data -- Mix

Even with overbuilding, we did not make the mix -- so we are not serving customers and using excess resources

Mix Performance			
Week of:	Pieces Scheduled	Pieces Produced	%
6/2/99	14,650	13,425	91.64%
6/9/99	16,990	14,798	87.10%
6/16/99	16,380	11,662	74.02%

The mix is now way off -- we are feeling the effects of the overbuilding



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Sample Lessons from Build To Schedule Data -- Overall Performance

As a components manufacturing plant, we have an exemption on measuring sequence performance

The performance trend is deteriorating rapidly -- all due to the way volume and mix are managed

Build To Schedule				
Week of:	Volume %	Mix %	Seq %	BTS %
6/2/99	100%	91.64%	100%	91.64%
6/9/99	100%	87.10%	100%	87.10%
6/16/99	96.18%	74.02%	100%	71.20%



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Appendix: Instructor's Guide

Slide	Time	Topic	Additional Talking Points
1-2	2-3 min	Introduction, overview and learning objectives	<ul style="list-style-type: none"> • Talk about linking the three key lessons together. Important to measure right; how to devise right metrics; and what can we learn from lean in devising metrics
3	3-5 min	Key Concepts	<ul style="list-style-type: none"> • Three key lessons
TBD	7-10 min	Exercises/Activities	<ul style="list-style-type: none"> • The CCA example; Some thinking on what does lean mean to metrics
TBD	5-7 min	Disconnects	<ul style="list-style-type: none"> • Important section explain all key points in the disconnects section.
TBD	2-3 min	Measurables	<ul style="list-style-type: none"> • Some examples of manufacturing metrics that are lean like First time through.
TBD	1-2 min	Concluding comments	<ul style="list-style-type: none"> • Summarize the three key lessons and disconnects



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Backup Slides



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Communication of Metrics

- Align individual performance with strategy
 - Communicate & Educate
 - Set Stretch goals
 - Link rewards to performance measures

- Measurements are meant to change behavior
 - Change happens thru people, so everyone needs to see a need to change
 - To achieve maximum motivation, goals should be moderately challenging.
 - Resolve issues to achieve goal: Lean metrics not only to evaluate but also to improve.



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Re-Assessment

- Continuous Improvement
 - Metrics Re-Assessment and Results teams at Raytheon
TI : PDCA Cycle.

 - Reassessment/Deployment Team
 - “Catchball” process
 - What is the benchmark capability?
 - Next Years Metrics should be?



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