

Fundamentals of Lean



Professor Deborah Nightingale
September 12, 2005



Lean is a New Approach to Managing Enterprises

- Origin and evolution of lean concepts
- Core lean principles & practices
- How lean differs from craft and mass production models of industrial organization
- Lean implementation steps
- Value stream mapping





Lean Enterprise Value: The Central Concept

Lean is a process of eliminating waste with the goal of creating value for enterprise stakeholders.

-Lean Enterprise Value, Murman et al



Lean Works Everywhere

- **Export licensing:**
 - 56 steps to 21 steps
 - 52 handoffs to 5 handoffs
 - Cycle time from 60 days to 30 days
 - 50% 1st pass yield to >90% 1st pass yield
- **Payroll:**
 - Reduced non-value added steps by 50%
 - 15 forms to 1 form
 - Reduced signatures/ approvals by 25%
- **Recruiting:**
 - Cycle time from 14 days to 48 hours
 - 50% reduction of paper resumes
- **Proposal:**
 - Cycle time from 30.6 days to 7 days
- **Program support:**
 - \$3M savings
- **Interface management:**
 - Proposal, contract, billing, and collection steps
 - Generated \$21M additional cash
- **Engineering order release:**
 - Cycle time from 76 to 4 days
 - Total queue time from 56 days to 60 minutes
- **Process definition:**
 - Work package completion cycle from 4 months to 3 weeks
- **Financial reporting:**
 - 13 weeks to 3 weeks





Lean was Born out of Necessity

August 15, 1945 -- end of war with Japan

- **Toyota faced a daunting challenge: How to succeed against Western mass production auto giants poised to enter Japanese market?**
- **Kiichiro Toyoda to Taiichi Ohno: “Catch up with America in three years.”**
- **Ohno’s challenge: How to design a production system exploiting central weaknesses of mass production model**

Japan’s dilemmas

- **Small & fragmented market, depleted workforce, scarce natural resources, little capital**
- **Lean evolved as a coherent response to this challenge over a number of decades -- a dynamic process of learning and adaptation later labeled as “lean production” by Western observers**



Use Less, Offer Greater Variety, Higher Quality, and More Affordable Products in Less Time

- **Best Japanese auto companies developed a fundamentally different way of making things**
- **These companies changed the dynamics of international competition**
- **New goals in manufacturing systems -- combined benefits of craft and mass production**
 - Improved quality
 - High productivity
 - Efficiency at low volumes
 - Production flexibility
 - Rapid, efficient development cycle
 - Product mix diversity
- **Lean production contrasts with traditional mass production paradigm**
- **Systemic principles are transferable**





What is Lean Thinking?

The removal of *muda!*

Muda- Is a Japanese word for waste

Waste- any activity that absorbs resources & creates *no value!*

Source: Lean Thinking by Womack & Jones



More Japanese Terms

- ***Kaikaku***- radical improvement

- ***Kaizen***- continuous incremental improvement





Types of Muda

- Mistakes which require recertification
- Production of items no one wants
- Processing steps which really aren't needed
- Employee or goods movement/transport from one place or another without any purpose
- People in downstream activity waiting because upstream activity has not delivered on time
- Goods and services that don't meet the need of customer



Antidote to Muda: Lean Thinking

- Provides way to specify value
- Line up value creating actions in best sequence
- Conduct activities without interruption whenever someone requests them
- Perform them more and more effectively
- Provides a way to make work more satisfying





Lean Thinking: Eliminating Waste with the Goal of Creating Value

- ❑ **Customer-focused:** Customer needs and expectations “pull” enterprise activities
- ❑ **Knowledge-driven:** Draws upon knowledge and innovation from everyone - workers, suppliers
- ❑ **Eliminating waste:** Stresses elimination, not just reduction, of all types of waste
- ❑ **Creating value:** Puts premium on “growing the pie”, not just reducing costs, to benefit all stakeholders
- ❑ **Dynamic and continuous:** Pursues on-going systemic as well as incremental improvement - both innovation and continual improvement



Lean Provides Positively-Reinforcing Concepts, Practices and Tools

- ❑ **Delivering just-in-time:** “Pull” based production
- ❑ **Striving for perfect quality:** Completely defect-free parts must flow to each subsequent process; quality designed-in, not based on inspection, mistake proofing
- ❑ **Flexibility and responsiveness:** Small processing sizes and quick set-up times; ability to respond to shifts in demand
- ❑ **Trust-based relationships:** Mutual commitments and obligations, internally and externally with suppliers
- ❑ **Continuous improvement (Kaizen):** Continuous improvement through work standardization, productive maintenance, root cause analysis, and worker training and empowerment





5 Steps to Becoming Lean

1. Define Value → Customer
2. Identify the Value → Follow the Product Stream
3. Flow the Product → Eliminate Waste
4. Pull → Produce Just-in-Time
5. Strive for Perfection → Continuously Improve



Five Lean Fundamentals

- **Specify value:** Value is defined by customer in terms of specific products & services
- **Identify the value stream:** Map out all end-to-end linked actions, processes and functions necessary for transforming inputs to outputs to identify and eliminate waste
- **Make value flow continuously:** Having eliminated waste, make remaining value-creating steps “flow”
- **Let customers pull value:** Customer’s “pull” cascades all the way back to the lowest level supplier, enabling just-in-time production
- **Pursue perfection:** Pursue continuous process of improvement striving for perfection

Source: James Womack and Daniel T. Jones, *Lean Thinking* (New York: Simon & Schuster, 1996).





1. Define Value

Definition

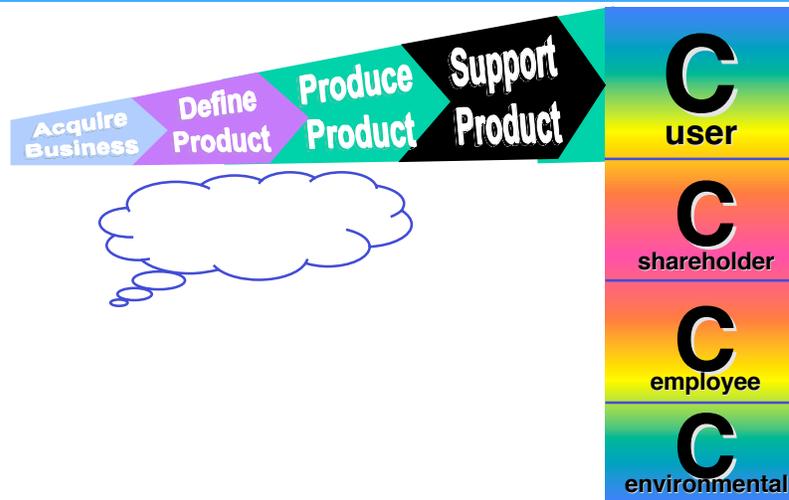
Information/Material in a Form That the
Customer Is Willing to Pay for

*Value is **Defined** by the Customer*

*Value is **Created** by the Producer*



Who's the Customer?





2. Identify the Product's Value Stream

The Value Stream Consists of the Actual Tasks Required to Bring a Specific Product Through Three Critical Processes:

Design -

Problem-solving From Concept Through Detailed Design and Engineering to Production Launch

Order -

Information Management From Order-taking Through Detailed Scheduling to Delivery

Make -

Physical Transformation from Raw Materials to Finished Product In the Hands Of the Customer





What Is a Value-Added Activity?

Definition

A value-added activity is any action that transforms information/material into a capability for our ultimate customer at the right time and the right quality.



Waste

Definition

Any Activity That Consumes Resources Yet Adds No Value





3. Flow the Product

1. Eliminate Activities That Are Pure Waste



2. Prefer One Piece Flow Where possible



3. Focus on the Product and Its Needs Rather Than the Organization or the Equipment

4. Focus on actual object and never let it out of sight from beginning to completion

5. Ignore traditional boundaries of jobs, careers, functions, and organizations to form a Lean enterprise removing all impediments to the continuous flow of the product

6. Rethink specific work practices and tools to eliminate backflows, scrap, and all stoppages



Batch Production Example

Throughput Time (5 Units) =

$$5 \times 1 + 5 \times 1 + 5 \times 1 + 5 \times 1 =$$

20 Min.

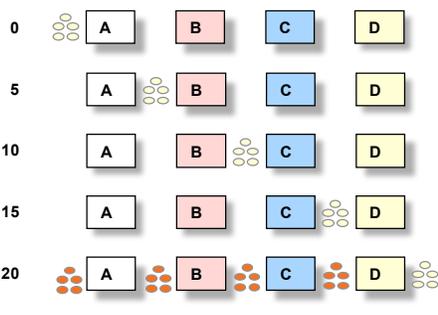
Work in Process

$$5 + 5 + 5 + 5 =$$

20 Units

A B C D = Different Processes
Processing Time = 1Min./ Unit

Processes - Oriented Layout With Transfer Lot Size of Five





Batch Production Example

Throughput Time (5 Units) =

$$5 \times 1 + 5 \times 1 + 5 \times 1 + 5 \times 1 =$$

20 Min.

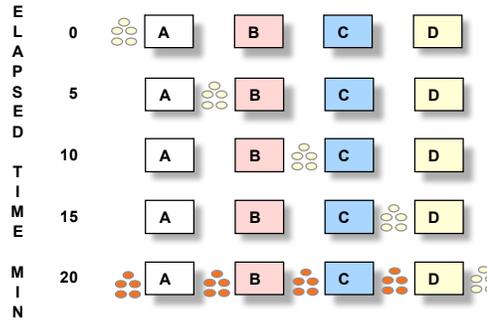
Work in Process

$$5 + 5 + 5 + 5 =$$

20 Units

A B C D = Different Processes
Processing Time = 1Min./ Unit

Processes - Oriented Layout With Transfer Lot Size of Five



One - Piece Flow Example

Throughput Time (5 Units) =

$$1 \times 4 + 1 \times 1 + 1 \times 1 + 1 \times 1 + 1 \times 1 =$$

8 Min.

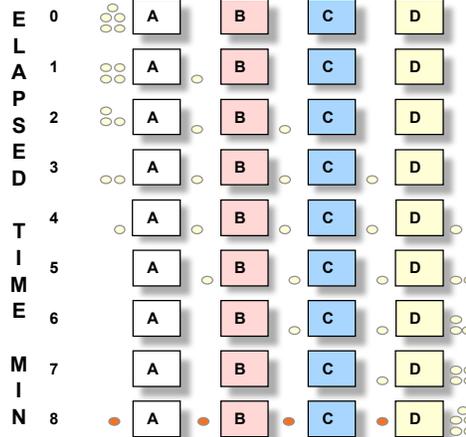
Work in Process

$$1 + 1 + 1 + 1 =$$

4 Units

A B C D = Different Processes
Processing Time = 1Min./ Unit

Product-Oriented Layout With Lot Size Of One





One - Piece Flow Example

Throughput Time (5 Units) =

$$1 \times 4 + 1 \times 1 + 1 \times 1 + 1 \times 1 + 1 \times 1 =$$

8 Min.

Work in Process

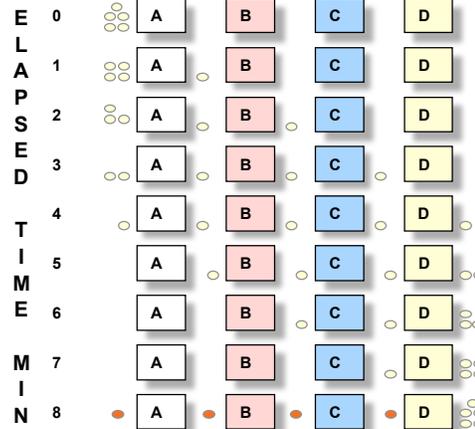
$$1 + 1 + 1 + 1 =$$

4 Units

 = **Different Processes**

Processing Time = 1Min./ Unit

**Product-Oriented Layout
With Lot Size Of One**



4. Pull

- Definition
- Letting the Customer Pull Value from the Enterprise
 - Don't Make Anything Until It Is Needed
 - Then Make It As Quickly As Possible





5. Strive for Perfection

- Continuous radical and incremental improvement
- Continuous Banishment of muda
 - Pursue Perfection, Not the Competition
 - There Is No End to the Process of Reducing Efforts, Space, Costs and Mistakes



Lean Thinking Differs Sharply from Craft and Mass Production in Important Ways

FOCUS	CRAFT	MASS PRODUCTION	LEAN THINKING
Focus	Task	Product	Customer
Operations	Single items	Batch and queue	Synchronized flow and pull
Overall aim	Mastery of craft	Reduce cost and increase efficiency	Reduce waste and add value
Quality	Integration (part of craft)	Inspection (a second stage, after production)	Prevention (built in by design & methods)
Business strategy	Customization	Economies of scale and automation	Flexibility and adaptability
Improvement	Master-driven continuous improvement	Expert-driven periodic improvement	Workforce-driven continuous improvement

Source: Lean Aerospace Initiative





Lean Thinking is Linked to & Complements Other Systemic Change Initiatives

	Total Quality Management	Reengineering	Traditional Six Sigma	Lean
Goal	Meet Customer Expectations	Breakthrough Solutions	Reduce Variation in all Enterprise Operations	Eliminate Waste to Create Value
Focus	Product Quality	Business Processes	All Sources of Product Variation	All Enterprise Processes & People
Scope	Business Unit	Business Unit	Enterprise	Enterprise Value Stream
Change Process	Incremental	Radical Change	Process-specific; continuous	Evolutionary Systemic Change
Business Model	Improve Efficiency & Shareholder Value	Increase Enterprise Performance & Customer Value	Minimize Waste & Increase Customer Satisfaction	Deliver Value to all Stakeholders

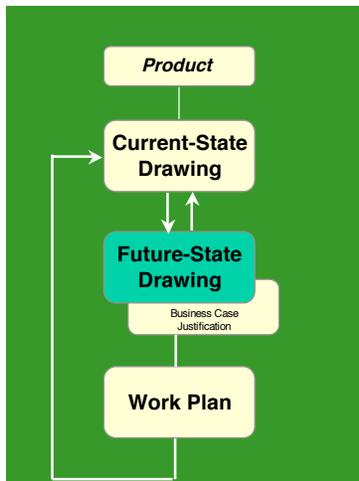


Value Stream Mapping





Using the Value Stream Mapping Tool



Understanding how the product currently flows

Designing a lean flow

How to get there





What is a Value Stream Map?

- **A Visual Representation of Every Process in the a Product's Path from Order to Delivery**
- **Includes:**
 - **Information and Materiel Flow Integration**
 - **Product Through-Put and Cycle Times**
 - **Resources Utilized**
 - **Value Added Times**
 - **Location of Significant Waste**



Why Value Stream Map?

- **Systems Approach To:**
 - **Visualize the Entire Product Flow**
 - **Identifies the Sources of Waste**
 - **Basis of an Lean Implementation Plan**
 - **Determine Future Operating State**





What Flows Through a Value Stream?

In Manufacturing... materials are what flows

“Material Flow”

**In Services...internal and external
customer needs and information
are what flows**

“Information Flow”

Identify and Remove Impediments to Flow



Why is VSM a Useful Tool?

- **Helps visualize interactions and flows**
- **Helps identify not only wastes but their sources as well**
- **Provides a common language for talking about a process**
- **Makes decision flows apparent**
- **Forms the basis of an implementation plan**
- **Shows the linkages between information and material flows**
- **Identifies the constraint(s) - any resource whose capacity is less than customer demand**

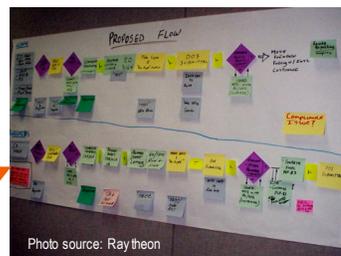
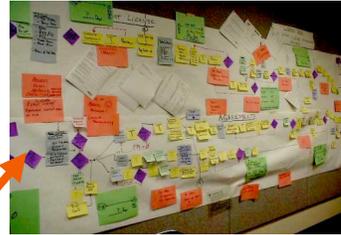
Source: M. Rother and J. Shook, *Learning to See*, Lean Enterprise Institute, 1998





Basic Steps to VSM

1. Define the boundaries
2. Define the value
3. “Walk” the process
 - ❑ Identify tasks and flows of material and information between them
4. Gather data
 - ❑ Identify resources for each task and flow
5. Create the “Current State” map
6. Analyze current conditions
 - ❑ Identify value added and waste
 - ❑ Reconfigure process to eliminate waste and maximize value
7. Visualize “Ideal State”
8. Create the “Future State” map
9. Develop action plans and tracking



Tips for Creating a VSM

- ❑ Involve entire team
- ❑ Actually walk the process - follow the material and information through the process, starting at the beginning
- ❑ Use post-it notes and butcher paper
- ❑ Use symbols or icons that are meaningful to the process but common enough to be understood by all involved





Administrative Process Value Stream Map - Current State



Process Steps:
56

Handoffs:
52

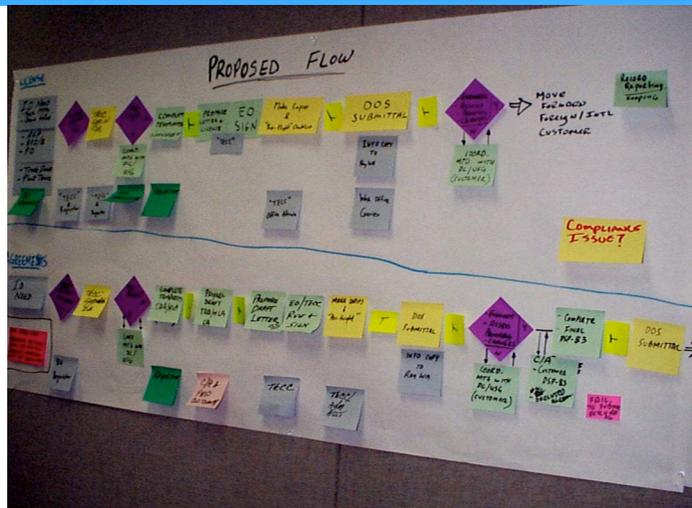
Cycle Time:
60 days

1st Pass Yield:
50%

Source: Raytheon



Administrative Process Value Stream Map - Future State



Process Steps:
21
62% reduction

Handoffs:
5
90% reduction

Cycle Time:
30 days
50% reduction

1st Pass Yield:
100%
100% improvement

Source: Raytheon





Keys for Success with VSM

Follow the Process

- Remember that value stream mapping & analysis is a process
- Avoid short-cuts...the steps are important!
- Remind yourself and your team to be disciplined

"We can skip this step"
"We already know how we want to make this"
"Let's not worry about that for now"

Learn by Doing!

*This
Process
Works!!*



Analyze the Current Condition Complete Red-Yellow-Green Dot Analysis

Value-Added Activities



- An activity that transforms or shapes material or information
- And the customer wants it
- And it's done right the first time

Non Value-Added – Needed Activities



- Activities causing no value to be created but which cannot be eliminated based on current state of technology or thinking
- Required (regulatory, customer mandate, legal)
- Necessary (due to non-robustness of process, currently required; current risk tolerance)

Non Value-Added Activities



- Activities that consume resources but create no value in the eyes of the customer
- Pure waste
- If you can't get rid of the activity, it turns to yellow





The Goal is to Eliminate Waste

Types of Waste

- Defects
- Over Production
- Transportation
- Movement
- Waiting
- Inventory
- Over Processing

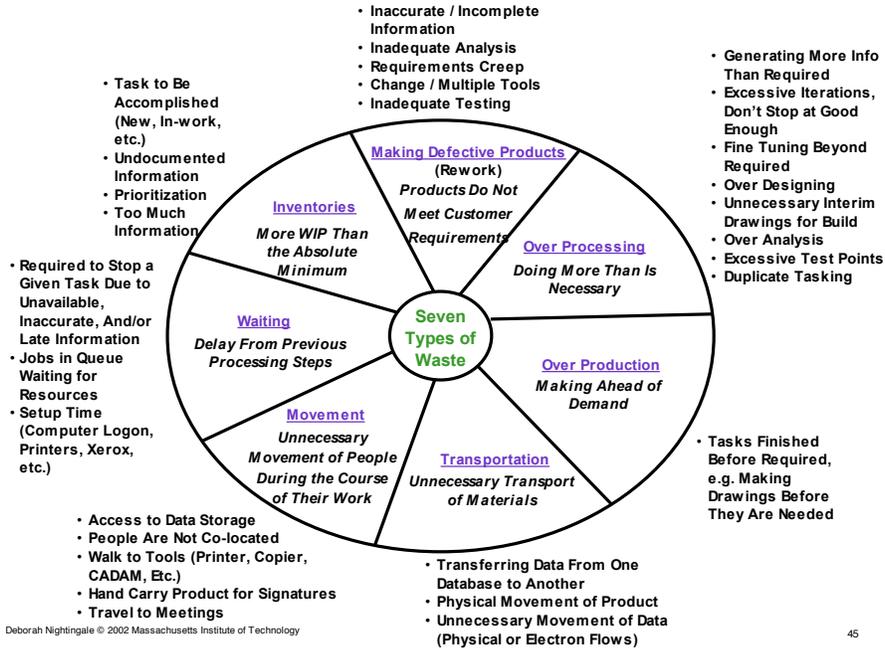


The Seven Types of Waste In Business Processes

Defects	incorrect data entry
Over Production	preparing extra reports, reports not acted upon, multiple copies in data storage
Transportation	extra steps in the process, distance traveled
Movement	extra steps, extra data entry
Waiting	processing monthly, not as the work comes in (i.e. closings)
Inventory	transactions not processed
Over Processing	sign-offs



Some General Product Definition Wastes



Exercise – Specific Examples You Encounter

