Bosch Rexroth Lean Seminar Series

Kurt Greissinger
Lean Seminar Agenda

Welcome, Intro to Lean (45 min)
- Lean Principles
- Lean tools
  - Waste Walks, Kaizen, Kanban, 5 Why’s, 5S

Workstation Design (10 min)
- Right sizing
- ESD control
- Ergonomics

Material Delivery & Storage (10 min)
- Benefits
- Warehouse case study
- Flow racks and carts

Factory Wide Implementation (10 min)
- Information Flow
- Workstation Linking
- Plant Layout

Lean Tools (15 min)
Next Steps / Q&A / Discussion / Working with the Tools
Introduction to Lean
Today’s Headlines

- The Greening of Lean Manufacturing
- Corporation Names Chief Lean Officer
- Lean manufacturing saving jobs
- Lean ERP Is Best Practice in Industrial Manufacturing
- Green Bay’s Lean Certificate Workshop Series announced for 2008
- Low Tech Succeeds in Expensive Massachusetts with Lean Manufacturing
- Lear Corporation’s Lean Manufacturing System Hikes Productivity and Reduces Costs
- Toyota Passes GM as Top Auto Seller
- U.S. Suit Maker Adopts Toyota’s Lessons
Lean is not about...

- eliminating jobs.
- removing automation from the process.
- completely eliminating inventory or finished goods.
- just manufacturing.
- only reducing waste.
- the automotive industry.
Rules of Thumb - Lean Benefits

- Double labor productivity
- Cut production throughput by 90%
- Reduce inventories by 90%
- Half the errors and scrap
- Fewer job related injuries
- Faster time to market for new products
- Wider variety of products made possible with little additional cost
- Modest capital investment

From *Lean Thinking*, Womack & Jones
Common sense is always wrong.

- Taiichi Ohno

- Why shut a machine down after making just enough production?
- Why eliminate the safety stock on the floor?
- Why have five smaller machines dedicated to separate product lines vs. a single, large machine that provides economies of scale?
- Why change over a machine several times in a shift instead of running one product all shift?

From Becoming Lean, Liker
History of Production Systems

1910
Taylorismus
Taylor, Ford

1940
REFA

1950
Start of Toyota Production System
Ohno, Toyota

1960
Kanban
Aggressive Selling
Scientific-labor studies

1980
Just in Time
TQM

1990
Planned Customer satisfaction

1992
7 Tools
SE

1997
TPM

2002
"The Machine that changed the World"
Womack, Jones

"Lean Thinking"
Womack, Jones

1950
Start of Lean Manufacturing

1992
Start in Western Hemisphere

Linear Motion and Assembly Technologies
Lean Manufacturing - Defined

“Lean Manufacturing” means...

... increase of efficiency and standardization by continuous improvements.

... a management system originating from the Japanese way of doing business.

... a staff which thinks, decides, supports and works with each other and for one another.

... a philosophy leading to processes with minimized waste.

... the introduction of a pull system, by means of just-in-time-delivery...

... customer orientation, quality orientation and cost reduction.

* Ohno: Founder of Toyota Production System

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Linear Motion and Assembly Technologies

Lean Principles

- Initiate
  - Specify value from the standpoint of the end customer
- Waste Elimination
  - Systematic waste elimination
  - Identify all the steps in the value stream, eliminate waste
- Flow
  - Directly observe work as activities, connections, and flows
  - Make steps in the value stream occur in a tight sequence so the product will flow smoothly towards the customer
- Pull
  - As flow is introduced, let customers pull value from the next upstream activity
- Organizational
  - Establish high agreement of what and how
  - Create a learning organization
  - Systematic problem solving
- Sustain
  - As transparency increases and waste is further eliminated, pursue perfection through continuous improvement

From Lean Thinking, Womack & Jones and The Hitchhiker’s Guide to Lean, Flinchbaugh & Carlino
Bosch Production System (BPS)

Customer Satisfaction and Business Success

Quality

Cost — Delivery

Perfect Quality — Process Orientation — Transparent Process
Flexibility — Pull System — Standardization
Waste Elimination — and — Continuous Improvement
Associate Involvement and Empowerment

Associate Satisfaction
Waste

**Value Adding**
- Tool in contact making chips
- Stroke of a press operation
- Filling in case of injection molding
- Mixing procedure in a chemical process
- Packaging of a product

**Concealed Waste**
- Traversing a tool
- Clamping a workpiece
- Cleaning and injection of the mold
- Refilling of reservoirs
- Change over, filling magazines

**Evident Waste**
- Waiting because of faults
- Double handling
- Deburring of a part, scrapping
- Placing into / releasing from stock, additional handling
- Additional cleaning

**For what the customer is prepared to pay.**

**Must be minimized, but can never be completely eliminated.**

**Must be entirely eliminated from the process.**
What are the forms of waste?

- Waiting
- Overproduction
- Excess Inventory
- Excess Transportation
- Overprocessing
- Errors and Defects
- Excess Motion and Movement
Inventory

Examples:
- Machine breakdown
- Missing Material
- Bottle neck at the shop floor
- Quality failings

Problems are hidden

Problems become transparent

Elimination of root causes

The elimination of the root causes allows a production with low stocks as well as sufficient flexibility and process safety.

The goal is to provide pressure to drive improvements.
People, Material, Information Flow

Material Flow Path (Before)

Material Flow Path (After)

Flow

Note:

- Transportation waste
- Double or triple handling of materials
- Extremely long production lead time
- Flow of material and operators’ work difficult to standardize

Note:

- Smoother material flow
- Improved ability to cross-train
- Reduced transportation
- No double or triple handling
- Reduced production lead time
Single Piece Flow

Batch Production

Process A → Process B → Process C

10 Minutes → 10 Minutes → 10 Minutes

30++ Minutes

Continuous Flow

“make one - move one”

Process A → Process B → Process C

??++ Minutes
A Lean Organization

- Must come from the top
- Free flow of communication required
- Requires management support
- Cultural change needed
- No end dates
- Does not need to be led by lean experts
- Start small
- Think big (entire process and value chain)
Transparency
Lean Tools

- Quality Circles / Perfect Quality / Quality Tools
- Kaizen / continuous improvement
- 5Y
- 5S
- Waste walks
- Standardization
- Direct observation of work (2-I’s)
- Time studies
- Changeover reductions
- Poka-Yoke
- Value Stream Mapping
- Lean line design
- Process leveling
- Supermarket
- Milkrun
- Jidoka
Kaizen

- “Change for the better” (Japanese)
- “Continuous improvement” (English)

Kaizen Blitz / Event  Mini Kaizen  Point Kaizen
Experimentation

- Experimentation and the opportunity to learn and fail is crucial to building a learning organization
  - The 70% solution
  - Mock-up with cardboard
  - Work with materials that are easy to assemble AND change
  - Formalize the results
Avoid defects through preventive actions and deliver perfect quality to the customer

**Elements of Perfect Quality**

**Definition of 5S**

- **Sort**
  - Purpose: A workplace is for working, not for storing

- **Straighten**
  - Purpose: A place for everything and everything is in place

- **Shine**
  - Purpose: Cleaning includes inspection

- **Standardize**
  - Purpose: Improvement is impossible without existing standards

- **Sustain**
  - Purpose: Maintain Standards through discipline

We always start here.

1. Sort
2. Straighten
3. Shine
4. Standardize
5. Sustain
Got Milk?
Failure Prevention Through 5S

Assembly board

Tagged area

Change-over tool cart
5 Whys?

Avoid defects through preventive actions and deliver perfect quality to the customer

**Q-Tools**

From the problem: "frequent machine breakdowns"...

1. Why has the machine stopped?  
   - "The fuse has blown due to an overload"
2. Why is the machine overloaded?  
   - "The spindle drive is not lubricated correctly"
3. Why is the spindle drive not lubricated correctly?  
   - "The oil pump is not working properly"
4. Why is it not working properly?  
   - "The oil pump axle bearing is worn out"
5. Why is it worn out?  
   - "Dirt has infiltrated the pump"

...to the solution:
- A filler is attached to the pump
- Scheduling preventive maintenance
2-I’s (2 Eyes) = Direct Observation of Work
Do you see what I see?
- Spring cup is assembled wrong (180° reverse)
- Change design at assembly press so that reversed parts would not fit under the press (difference of length with part upside down)

Device to stop incorrectly placed parts from moving to the next operation
Jidoka

... not allowing problems to pass from one work station to the next. (NUMMI)

... stopping the process to build in quality. (Liker-Toyota Way)

... Stopping a process when something goes amiss. (Strategos)

"stop and respond to every abnormality."

... makes it impossible for defective parts to pass unnoticed through the line. (Monden)

... "autonomation" or "automation with a human touch." (Shingo)

* Definition of the Jidoka pillar in TPS
Without standardization, there is no Kaizen!

- Standard work sheets
- Maintenance plans
- Test plans
- Escalation rules
- Only good parts go to next process
- Production stops at deviation from standard
- Responsibility and involvement of operator
- Visualize actual situation at machine
- Communication
- Leadership involvement
Jidoka

Traditional Approach:
- Use of final inspection processes
- Standard rework stations
- High inventory hides first-pass yield issues
- Little/no feedback to operations producing defect
- Slow reaction to quality problems

Jidoka Approach:
- Identification of defects at source of the problem
- Immediate reaction to abnormalities
- Countermeasures prevent passing defects to next operation
- Involvement of all associates in problem-solving process
Jidoka is a 4-Step Process

1. Detect the abnormality.
2. Stop the process.
3. Fix or correct the immediate condition.
4. Investigate the root cause and implement a solution.

**Tools:**
- Andon
- Poka-yoke
- 5-Why Boards
**Kanban**

\[ \#K = \frac{DR \times RT \times (1 + \alpha)}{NC} \]

**DR:** Production requirement pcs/time  
Analyze customer demand (Takt Time)

**NC:** Container capacity  
Number of parts per container (lot size)

**RT:** Replenishment time  
Time required to refill the supermarket. This time is a value for the agility of the system.

**\( \alpha \): Safety factor**  
Shows as a number the waste in the system. Safety for:  
- short term and limited fluctuation  
- fluctuation out of production (batch processes)  
- uncertain supply chain
Kanban Solutions

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Value Stream Mapping

Manage the implementation projects and measures to achieve the benefits of the future state design.

Develop and agree on a vision for an improved, customer oriented material and information flow.

Understand the current situation and organization in the area.

Use PQPR process to define product families.

Product Family Definition

Future State Map

Current State Map

Implementation Plan
Value Stream Mapping – Current State

ACME Current State Map

Takt Time = 60 secs

Linear Motion and Assembly Technologies
Value Stream Mapping – Future State

The Lean Value Stream

Michigan Steel Co
500 ft coils

6 Week Forecast
Daily Fax
Production Control

90/60/30 day Forecasts
Daily Order

Steel Street Assembly

18,400 pcs/mo
-12,000 “L”
>6,400 “R”
Tray = 20 pieces
2 Shifts

EPEI/Kanban
Total work <165 secs

Stamping

Weld + Assembly

Uptime 1.5 days
1 sec
Weld Changeover 165 secs
2.0 days

Based on the works of Mike Rother & John Shook from The Lean Enterprise Institute

Production Lead Time = 5 days
Processing Time = 166 s
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Next Steps / Q&A / Discussion / Working with the Tools
Workstations
Customized Workstations

Design considerations for workstations:

- Size of the product to be assembled
- Required process steps or equipment
  - Ergonomic positioning of tools
- Material supply philosophy
  - Number of grab containers
  - Logistics run frequency

Flexible solutions that meet your requirements!
Workstation Examples
Right Sizing
Right Sizing
Right Sizing

- Most common, lean work surface sizes defined by Bosch Rexroth
  - Width = 1000mm (39"), 1200mm (47"), 1400mm (55")
  - Depth = 555mm (22"), 705mm (28")

Prevent Overproduction
in nature  

during manufacturing
ESD Workplace Systems Problems caused by Electrostatic Charging

- Discharge shock in people
  Example: incorrect reactions resulting from surprise at an electric shock

- Dust and dirt attraction
  Example: layer of dust on monitor

- Handling problems
  Example: document sleeves sticking to each other

- Danger of fire and explosion
  Example: explosion of the "Hindenburg" blimp

- Product damage
  30% of faults in semiconductor component elements

- Product malfunctioning
  example: an airbag triggered by entering or leaving vehicle

Danger of fire and explosion
Example: explosion of the "Hindenburg" blimp

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30% of faults in semiconductor component elements

Product malfunctioning
example: an airbag triggered by entering or leaving vehicle

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Example: layer of dust on monitor

Handling problems
Example: document sleeves sticking to each other
ESD Failure Mechanisms

Complete failure
10% of ESD faults

Damage/change in characteristics
90% of ESD faults
Electro-Static Discharge (ESD) Control

Linear Motion and Assembly Technologies

Indicators of the Need for an Ergonomic Program

- Trends in accidents and injuries
- Cumulative trauma disorders
- Absenteeism, high turnover
- Employee complaints
- Employee generated changes in the workplace
- Poor product quality
- Repetitive motion tasks

Ergonomically designed production systems ensure:
- Reduced fatigue
- Increased productivity
- Optimized use of resources
- Motivated workers
Ergonomics Checklist

Take body height into account

Grab area size

Optimize position of containers and material flow
Ergonomics Checklist (cont.)

Avoid working over the heart

Properly set workstation equipment

Take vision into account
Right Lighting

Adapt illumination to the task at hand

500 lux 1000 lux 1500 lux
Effect of Right Lighting

Increased Productivity with Bosch Rexroth Lighting

Decreased Errors with Bosch Rexroth Lighting

Eliminate errors and defects
Lighting Options

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Linear Motion and Assembly Technologies
5S & Ergonomic Accessories

Relieves shoulder, neck, and back problems due to handling heavy tools and prolonged standing

Keeps work surfaces organized
Largest variety of plug-and-play accessories!
Material Delivery and Storage
Grab Containers

Plastic

VarioGrab

Up to 30% reduced inventory!
Customized Flow Racks

Supermarket rack:
- "Shopping possibility" for logisticians
- Customers define their own standard
- Modular and flexible designs

Defined supply systems according to the FIFO principle
Free-up captial and space by reducing inventories
Flow Rack Systems

Flow rack systems

- Inventory reduction by defined material supply
- Increased transparency due to FiFo principle
- Modular extendable flow racks reduce material and cost efforts
- Easy conversion and extension
Material Shuttle

In the workplace

Logistics

Standard

Material carts

- Eliminates carrying heavy/bulky parts
- Easy positioning of bulk parts
- Easy reconfiguration to accommodate left/right hand or change in body size between workers

Eliminate waiting

Minimize Excess Motion
Warehouse Case Study – Initial State

Problems:
- Poor labeling / no labeling
- No FIFO
- Picking / replenishing conflict
Warehouse Case Study – Current State

Solutions:
- Dedicated rows
- Reduced motion in “Pick” aisles
Warehouse Case Study – Current State

Solutions: Gravity-fed rollers integrated in existing racks
FIFO of parts

Next Steps:

Prioritize part numbers based on usage / consumption
Move “heavy hitters” closest to shipping
Material Flow
Factory Wide Integration
Information Flow

Establish Standardization
Increase transparency
Improve quality

Eliminate errors and defects
Posting standard work instructions ensures employees are doing their jobs right.

Work instructions should include:
- Process flow / sequence
- Cycle time
- Safety items
- Quality checkpoints
- Response to abnormal or non-standard conditions

From *Gemba Kaizen*, Imai
Information Flow
Material & People Flow

- Workcell creation by linking workstations with manual conveyors
- Quick construction by drop-in rollers and structural Aluminum elements
- Customized modules enable simple design

Reduce Transportation  Eliminate overproduction
Linked Modular Workstations = Lean Line
People Flow
Problems: Assemblers pick own parts
Racks 3.5m apart for forklifts
Ladders needed for 3m racks
Workcell Case Study – Initial State

Problems:

No Kanban or FIFO at workcell or racks
Cells with multiple 3m wide workstations
**Workcell Case Study – Current State**

**SM1**

**WCS**

**Solutions:** Two supermarkets

- SM1 parts delivered on-demand (production order)
- WCS parts delivered per Kanban (empty bin)
- Supplier managed hardware
- New racks 1.8m tall and 1m apart
- No ladders
- No fork lifts
- Material handling separated from value-add
Workcell Case Study – Current State

Solutions:
- 1m wide workstations (Right Sizing!)
- Each workstation contains 15min of work
- Workstations on wheels for flexibility
- 2-bin Kanban system
- Production Order items delivered on carts (signals demand)
MPS Lean Line – ESD Edition
Lean Cell Concepts
Lean Tools
Design Software & 3-D Libraries

STP Format
DXF Format
TIF Format
SolidWorks Format
SAT Format
DWG Format
MPScalc Design Software

1. Request

2. MPScalc
   - Choose parameters

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<td>Workstation height (H) / mm (500 - 1100)</td>
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<td>Rear shelf height (H2) / mm (1000 - 2500)</td>
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<td>Material thickness (M)</td>
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<td>Material shelf depth (T1B) / mm (400 - 1300)</td>
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3. Result
   - Order form
   - Part number
   - Price
   - 3-D model
   - CAD model
MPScalc Design Software

- request
- drawing
- parts list
- quotation
- order
- delivery

Traditional

\[ \sum \text{MPScalc} \]

Time and cost savings
Reduction in waste

Linear Motion and Assembly Technologies
Lean Resources

- Lean webletters
- www.boschrexroth-us.com/lean
- www.boschrexroth-us.com/mps
- GBMP
- Lean Learning Center
- Google or other major search engines
Lean Podcast Series

Featuring:

- Jamie Flinchbaugh…
  - Lean Learning Center, The *Hitchhiker's Guide to Lean*, monthly *Assembly* magazine feature
- …and Liz Cohen as the Voice of Lean
  - ATE featured presenter

Monthly – Quarterly Roadmap for Releases
Example topics:

- Front-line supervisors in Lean
- Designing Manufacturing Equipment for Lean
- Applying Lean to the Engineering Process
- Gaining Buy-in for Lean
- Others?
Partnership of Lean Trainers, Consultants, Authors, Equipment Suppliers and Lean Tool Suppliers

Members:
- Bosch Rexroth
- Toyota
- Omron STI
- Leonardo Group Americas
- Orgatex Americas
- SSI Schaeffer

Global presence
Opportunities to work together include:

- Local Support for Initiatives
- Lean Cell Design
- Machine Guards
- Structural Applications
- Custom Application Work
- Systems
- Service & Repair
Next Steps
Lean Beginnings

- Share what you learned today!
- Learn more
- Receive buy-in from the top
- Develop a vision
- Set improvement goals
- Select a test area
- Work with your local Bosch Rexroth distributor
- Work with a Bosch Rexroth Certified lean consultant
- Begin with the end in mind
- Stick with it!
Waste Walk Invitation

What are YOUR forms of waste?

- Waiting
- Overproduction
- Excess Inventory
- Excess Transportation
- Overprocessing
- Errors and Defects
- Excess Motion and Movement
Bosch Rexroth Assembly Technology
Supplier of Complete Solutions for the Lean Factory