



CEMD 0920



Basic Manufacturing Skills Week 5



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Student Learning Objectives

- At the end of this course... You will
 - Understand & Identify Value vs. 7 Wastes
 - Understand how a Value Stream Map is used
 - Be able to calculate take Time
 - Understand and be able to identify Root Cause
- AND:
 - Understand how Lean Manufacturing impacts Business Metrics as Cycle Time & Inventory

Agenda

- Lean definition
- Lean Thinking – the Value
- Lean Principles – House of Toyota
- Lean Enablers (Tools)
- Lean Countermeasures (Tools)
- Overview Advanced Tools

Lean and Simplification

The Spirit...Integrity of the product,
process and actions

The Letter...Adherence to the rules

- Standardize
- Create/follow standard processes
- Measure against the Std

What is Lean?

- The relentless pursuit of the perfect process through waste elimination
- An evolutionary search for better processes that is never complete.
- A strategy for maximizing value for the customer.
- Straight forward principles tied to deceptively difficult execution.
- A set of principles that can apply to any process.

Why do Lean?

- Improve performance
- Increase capacity
- Increase quality through simplification
- Increase customer/market responsiveness through cycle time reduction

Customer satisfaction = business prosperity

Lean Six Sigma Integration

How do you build in quality and get speed? By applying Lean & Six Sigma

Lean

- Focus
 - Waste
- Basics
 - Customer value
 - Process
 - Flow
 - Pull
 - Perfection
- Tools
 - Simulation
 - Value stream maps
 - Standard work
 - Visual management
 - Take time

Six sigma

- Focus
 - Variation
- Basics
 - Process
 - Correlation
 - Discipline (DMAIC/DFSS)
 - Data
- Tools
 - QFD/CTQ Flowdown
 - Scatterplots, Pareto
 - Trade-Off Tools
 - Reliability
 - Robust Design

DMAIC

- D
 - Define
- M
 - Manage
- A
 - Analyze
- I
 - Intergration
- C
 - Control

Lean system

The 5 steps to Lean Thinking ...

- 1. Specify Value**
 - Define value in from the customers perspective and express value in terms of a specific product
- 2. Map the Value Stream**
 - Map all of the steps...value added & non-value added...that bring a product of service to the customer
- 3. Establish Flow**
 - The continuous movement of products, services and information from end to end through the process
- 4. Implement Pull**
 - Nothing is done by the upstream process until the downstream customer signals the need
- 5. Work to perfection**
 - The complete elimination of waste so all activities create value for the customer

Specify the value

Specify the value

- **Define value in from the customers perspective and express value in terms of a specific product**

Understanding Customer Needs

- What is it?
 - Know your customer's needs – Internal and External
 - To correctly identify value from the customers' perspective
 - To clearly identify Muda or 'waste' in the customers' eyes
- Sources of Customer Input
 - Go and See...Observe
 - External studies...marketing segmentation
 - Reflection on past failures to learn
 - Current Data from Customer Complaints
 - Surveys
- Principles for implementation
 - Ask how current products and processes effect your customer's value expectation
 - Ask what is needed, when and how many?
- Potential Pitfalls and Remedies
 - Never assume, always ask and Go & See for yourself
 - Don't forget past failures and Identify the True Root Causes to Eliminate the problem from happening again

Specify Value

- **Value-Added Work**
 - Steps that are essential because they physically change the product/service. The customer is willing to pay for them and are done right the first time
- **Non Value-Added Work**
 - Steps that are considered not essential to produce and deliver the product or service to meet the customer's needs and requirements. Customers not willing to pay for step.

Specify Value Cont.

Eliminate

- Unnecessary Waste
 - Reworks
 - Missing Information
 - Waiting for material/information

Minimize

- Essential waste
 - Tracking waste
 - Export control

Value

- Designing product/process
- Testing prototype
- Documenting the work

Lean system – The Value

- **Value Added Activity**
 - Any activity that changes the form, fit or function of materials or information for the customer...or, other activity that customers are willing to pay for
- **Non-Value Added Activity**
 - Anything else that we do!

Increased Process Velocity

Identifying Waste (Muda)

7 types of waste

1. Transportation
2. Over production
3. Motion
4. Waiting
5. Inventory
6. Defects
7. Extra Processing

**“Lean” Targets the Waste and Eliminates It ...
QUICKLY!**

Types of Waste - Examples

7 wastes	Manufacturing Flow	Transactional Flow
Transportation	<ul style="list-style-type: none"> - Conveyance of any materials, tooling - Conveyance systems 	<ul style="list-style-type: none"> - Delivering Hard-copies - Shipping hard copies that requiring signature
Over production	<ul style="list-style-type: none"> -Sub assemblies and components between feeder & main lines 	<ul style="list-style-type: none"> - Processing before next operation is ready - Processing prior to need
Motion	<ul style="list-style-type: none"> - Operators bending, turning, twisting, reaching, walking - Machines 'cutting air' - Robotic motion 'getting back to home' 	<ul style="list-style-type: none"> - Navigating multiple screens to input data - Printing material - Ergo,... walking, bending, twisting - Looking for data/info
Waiting	<ul style="list-style-type: none"> - Operators waiting - Machine waiting - Customers waiting 	<ul style="list-style-type: none"> -Info awaiting an overnight 'system batch run' - Manual decisions - System downtime/response time
Inventory	<ul style="list-style-type: none"> - material between operations & process steps -Inventory stored in warehouses 	<ul style="list-style-type: none"> - multiple credit applications awaiting approval - unnecessary document/data storage
Defects	<ul style="list-style-type: none"> - Poor quality of materials - Equipment failures - Missing customers due dates 	<ul style="list-style-type: none"> -Personal data incorrect -Missed customer due dates -Date entry errors
Extra Processing	<ul style="list-style-type: none"> -Planned rework -Unplanned rework - handwork ... polishing, deburring 	<ul style="list-style-type: none"> -Navigating multiple screens to input data -Multiple ways to do the same tack - duplicate entries

Map the Value Stream

Map the Value Stream

- **Map all of the steps...value added & non-value added...that bring a product of service to the customer**

Why Map a Process?

- Any Process has at least three versions
 - What you THINK it is:
 - What it ACTUALLY is
 - What it SHOULD be

Identify Value Stream

All of the following actions, both value added and non-value added, currently required to bring product from raw materials to the customer

- **Sales, Marketing, Engineering, Customer Service, ITL, Purchasing, etc.**
- **Manufacturing**
- **Shipping, Accounting**
- **Customer**

What is a Value Stream Map for ?

- Diagnostic visualization and communication tool used to show an entire system
- Documents the Current State Process
- Basis for developing a Future State
- Identifies how value flows to the customer
- Shows where flow stops and inventory builds
- Shows linkages between information and material flows
- Helps us understand and improve big Business Processes... NPI, ITO, and OTR
- forms the basis for an improvement plan
- makes waste visible

Allows you to see the complete system from start to finish!

Traditional System : Push

- Outputs are generated as fast as possible.
- Expediting is the norm.
- Stacks of obsolete inventory are common
- Long list of projects “initiated”, few completed.
- Despite piles of inventory, what the customer wants is seldom available.
- Push Hides Problems in Inventory

Flow is...

- Movement of products, services and information down the value stream
- Objective is continuous flow as product, service and information is transformed by continuously adding value
- Flow is created by eliminating Queues and Stops and improving process flexibility & reliability

Batch Process vs Flow process

Batch process

- Lead times are long because each process step is batched and must wait for the others to be completed before the next process can be started.

Flow Process

- Using one piece flow, lead time is reduced and quality is improved !!

Implement Pull

Implement Pull

- Nothing is done by the upstream process until the downstream customer signals the need

Pull Where You Cannot Flow

- Some processes cannot be operated as a Flow:
 - Long distances between processes
 - Unreliable processes
 - Long setup times
- Pull Systems (Supermarkets) are used to maintain level operations

Establish Pull

- End customer initiates pull process
- Each step in the process takes the product it needs, when needed from the proceeding process
- Only the amount required is taken

No action is taken until the downstream customer initiates it For the most part, “Pull” comes naturally in a transactional environment provided the customer is driving the activity.

Work for Perfection

Work for Perfection

- The complete elimination of waste so all activities create value for the customer

Perfection

- Perfect output
 - is delivered immediately
 - is defect free
 - is delivered one request at a time
 - is produced without waste
- Kaizen is the road to perfection... continuous improvement

QUIZ 1

1. Lean manufacturing is a:

- a) Japanese art
- b) A methodology to improve responsiveness to the customer by eliminating non value added steps of process
- c) A methodology to raise cost of the product
- d) A set of tools to make people work faster

2. What is a Value Stream Map for?

- a) Documents the Current State Process, Make waste visible, Identifies how value flows to the customer
- b) A tool to identify products over a production line
- c) A marketing study and strategy
- d) A tools to collect Voice of Customers

3. Which of the following is not one of the seven wastes?

- a) Overproduction
- b) Transportation
- c) Cost
- d) Waiting

4. One-piece-flow means:

- a) Batch
- b) Larger lot sizes
- c) One piece moves to the next operation
- d) Operators need to work harder

Lean Principles

The Toyota House

A system...not just a set of tools

Lean, as embodied by the Toyota Production System, is frequently viewed as a House with Foundation, and Pillars

What is Heijunka?

Heijunka is the foundation of the Toyota Production system, and is the process of leveling and sequencing an operation.

- Heijunka means level-loading products/production
- If you are trying to have necessary working capacity to meet the production peak, it creates huge Muda for people, material and equipment.

Supply Chain vs Shop Floor

Supply Chain

Supply Chain Impacts...

- Quality Issues
- Inventory Swings
- Reactive Nature Driven Into Culture!

Supply Chain Benefits...

- Creates Environment for Standardized Inventory Balances

Shop floor

Shop Floor Impacts...

- Excess Overtime
- Increase Inventory/No Inventory
- Customer/Delivery Issues Shortages Occur
- “Work Around” Culture Results

Shop Floor Benefits...

- Perform Std. Work to Take Time
- Setting Pace for Supply Chain/ Production
- Timely Signaling PO's to Supply Chain
- Inventory levels relative to Takt Time, Standardized!

What is Jidoka?

Jidoka allows machines to operate autonomously by shutting down automatically if an abnormality occurs. This prevents defective products from passing to the next process.

2 Main Elements:

1. Automation
Automation with human intelligence.
Example: Printer checks for low ink level
2. Stop at an Abnormality
Process stops to initiate action at point of occurrence.
Countermeasure implemented to prevent repeat occurrence

What is Just-in-Time?

Just-in-Time provides the customer what is needed, when it is needed, in the quantity it is needed.

3 main elements

1. **Single Piece Flow:** Completing the process from start to finish continuously.
2. **Pull Production:** A system in which each process takes what it needs from the preceding process when it needs it and in the exact amount needed
3. **TAKT Time:** Frequency at which unit should be completed in order to meet customer demand

Kaizen

What is it?

- Kaizen means “Change for the better” or “Continuous Improvement”

A hands-on process of short duration to develop iterative solutions, with each iteration an improvement on the last.

Why implement?

- Motivation of employees
- Waste reduction
- Productivity increase
- Quality improvement
- Just In Time Delivery
- Customer satisfaction

Kaizen Cont.

Principles for implementation

- **Get Everyone Involved**
 - Look for Ideas Everywhere
 - Get Your Hands Dirty
 - Participation of technicians/experts – they are the one who know the work (at least 50%)
- **Turn Ideas into Actions**
 - Tools Target Process Waste
 - Just Do It...20% Plan, 40% Do, 40% Re-Do
 - Trystorm...try-observe-improve, over & over
- **Use Resources Wisely**
 - Creativity Vs \$\$... Spend \$\$ as if it were your own

Quiz 2

1. The 3 Just In Time elements are

- a) Single Piece Flow, Pull Production, Cycle Time
- b) Single Piece Flow, Pull Production, Takt Time
- c) Single Piece Flow, Push Production, Cycle Time
- d) Single Piece Flow, Push Production, Takt Time

2. Autonomation is automation without human intelligence

- a) True
- b) False

3. The Lean Term “JIDOKA” is defined as:

- a) Continuous improvement in the office and the shop floor.
- b) Automation with a human touch.
- c) A form of martial Arts.
- d) Creating value for the customer.

4. The definition of "Kaizen" is...

- a) Better throughput
- b) Non Quality products
- c) Higher employee bonus
- d) Change for the Better

Lean Enablers Part I

Standard Work Overview

What is it?

- The best known combination of people, materials machines and space carrying out production in the most efficient method
- The same thing, the same way, every time

Why implement?

- To eliminate variation, drive quality
- The baseline for Kaizen or improvement
- There is no improvement in the absence of standardization !!!

Principles for implementation

- Three basic elements
- TAKT Time
- Work sequence (order of operations)
- Standard work-in-process (SWIP)

Takt Time

- TAKT time
 - TAKT Time: Serves as the rhythm or beat of the process. It is the frequency at which a product or service must be completed in order to meet customer needs. The TAKT Time formula is $\text{available time} / \text{required production (demand or forecast)}$.

Takt Time Cont.

Takt Time will be your reference to organize operator workload and balance your lines:

- Define Work Sequence
- Calculate Number of operators
- Calculate Standard Inventory

Work Sequence

- The work sequence is the operation order in which a worker carries product, loads and unloads them from equipment, etc. It should all the added value actions needed to manufacture products.
- This is different from “*process sequence*” which is how a product is made.

Go & See...the power of observation

- Go to the GEMBA...where the work happens
 - (ie factory floor, transaction processing area, ride with field engineers...)
- Watch the process happen
- Draw what you see
- Collect time based data (ie stop watch)
- Understand how operators work
- See the flow of information
- Map all of the steps in the process
- Document the 7 wastes
- See non-value added activities
- See rework loops
- Try-storm new solutions

Create Standard Operations

STEP 1. Time Observation Sheet

- Used to document the work sequence for one operator
- Typically, 7 to 10 observations are taken
- Calculate the best sequence, you could use :
 - The lowest observable cycle (assuming no abnormalities in the sequence)
 - The average (assuming a low spread)
 - The lowest repetitive cycle times for a given step

Key input to the Yamazumi chart & Standard Work Combination Sheet

Create Standard Operations

STEP 1. Time Observation Sheet Cont.

- How to complete it
- Step 1: List the work sequence
- Step 2: Record time with a running stopwatch
- Step 3: Do calculations.

One form per operator

- ✓ If you miss a time, keep going – don't stop
- ✓ Make sure your observation points make sense from operation perspective
- ✓ Note any areas for kaizen as you are taking times.

Create Standard Operations STEP2.Standard Work Combination Sheet

- SWCS combines human and machine movements based on takt time. It is used to determine work sequence for operator.
- ✓ Graphically “combines” the interaction of the operator and equipment.
- ✓ Provides for a repeatable standard to follow.
- ✓ Compares relative cycle times with TAKT Time.
- ✓ Used to identify areas for improvement.

Create Standard Operations STEP3.Standard Worksheet (spaghetti map)

- ✓ Details the work sequence of an operator visually.
- ✓ Shows the operator's work sequence in respect to the physical work area.
- ✓ Highlights Standard WIP requirements, gage, and safety precautions.
- ✓ Useful in visually detailing operator assignments.
- ✓ Also used as an audit tool for supervisors.
- ✓ Helpful when new operators are assigned to the work area.

Create Standard Operations STEP3.Standard Worksheet

How to complete it

1. Develop work area layout showing equipment to be included in the Standard Work
2. Show the patterns of steps to be used by operators in performing to the Standard
3. The standard amount of WIP Necessary to maintain the Standard Work Combination Should be shown and controlled

SWIP Calculation

SWIP – Standard Work In Process

- The minimum work in process required to perform repetitive operations

$$SWIP = \text{Cycle Time} / \text{Takt Time}$$

Create Standard Operations

STEP 4. Yamazumi Chart

Definition

Stacked bar chart showing cycle time workloads balance between operators

- ✓ Can be either for a single product or multi product assembly line
- ✓ Detail cycle time for all operators
- ✓ Compare operator cycle times to TAKT Time
- ✓ Allows supervisor to understand staffing requirements at a glance
- ✓ Facilitates the kaizen opportunities

Each step of the process must produce to TT to assure a steady, stable flow of outputs that meet customer requirements

Create Standard Operations

STEP 5. Production Capacity Sheet

- ✓ Used to calculate the capacity of all equipment.
- ✓ Uses Processing Cycle Time
- ✓ Highlights processes that are bottlenecks (where Processing Cycle Time > TAKT Time).
- ✓ Proactive tool – allows for “what-if?” scenarios.
- ✓ One sheet per cell.

Lean Enablers Part II

5S

- Sort
 - Separate the needed items from the un-needed items, then remove to a "red-tagged" location
- Set in Order
 - Arrange in a way for how the remaining items will be used
- Shine
 - Maintain the work area for the already sorted and set-in-order items
- Standardize
 - Ensure sort, set-in-order, and shine are consistently followed across all users
- Sustain
 - Maintain and improve sort, set-in-order, shine, and standardize

You're Already Using 5S...

You likely use 5S at home without even knowing it.

At home, 5S keeps us organized, helps us better utilize space, and allows us to find what we need more rapidly

Examples

- Organizing tools in a tool box
- Closet organizers
- Garage organizers
- Silverware trays

5S in Manufacturing

What you should expect ...

- 30% Reduction in mean pick time per order
- 45% Reduction in walking distance to pick
- 40% Reduction in on hand inventory
- Pick document from 13 pages to 1

5S in Manufacturing - Examples

Create Standards ... Detect Abnormalities

- Work Stations Identified
- Locations Labeled
- Material Out/Material In
- Standards Established

Visual Management Overview

What is it?

- Management at a glance
- Raising abnormalities

Why implement?

- So anyone can understand the current situation
- To trigger the correct response or action
- See the problem

How implement?

- Create a shared understanding of the standard
- Implement tracking, charting, labels, signs, production boards, foot printing, etc...

Visual management helps teams understand the current situation and create the correct response

Visual Management

5 cowboys to drive 1000 cattle

- Should take one look and understand the situation
- Clearly differentiate between what is “Normal” and “Abnormal”
- Detect what is “Abnormal”
- Don’t “Manage” a Standard ... Detect the Abnormality

Visual Management Using 5S to drive action

- **All items should be clearly labeled,**
- **It should be easy to see what's out of place**

Nascar Video

[Nascar in Slow Motion](#)

QUIZ 3

1. Calculate Takt Time using the following variables

- Demand 850 units a day
- Hours per shift: 8 hours, 2 shifts
- Break duration 2*30 min
- Lunch Break duration 60 min

2. Time Observation Sheet, Standard Combination Work Sheet Standard Worksheet and Production capacity Sheet are used for

- A. One operator
- B. All operators on the line
- C. Only 2 operators on a same line

3. What is Production Capacity Sheet used for?

- A. Calculate Standard WIP
- B. Calculate the capacity of all equipment
- C. Calculate Takt Time

4. What are the “5-S” of workplace organization?

- A. Sort, Section, Synthesize, Sustain, Success
- B. Sort, Shine, Set in Order, Standardize, Sustain
- C. Sort, Shine, Set in Order, Standardize, Success
- D. Set, Scrub, Sort, Sustain, Standardize

Lean Countermeasures

Lean Toolkit at a Glance

Thinking & Principles

“Newton’s Laws” of Lean

- Value versus Waste
- Heijunka
- JIT
- Pull
- Takt Time
- Single Piece Flow
- Jidoka

Enablers

What helps to achieve goals?

- *VSM (explained previously)*
- Standard Work
- 5S
- Visual Management
- 3P
- Action Workout
- Set Up Reduction
- TPM
- Supermarkets
- Mat’l Presentation
- Waterspider
- Moonshine

Countermeasures

Controls in Place

- 5 Whys and Root Cause Analysis (RCA)
- 6Ms Fishbone
- Poka-Yoke
- Stop at abnormality
- ...Expose waste...
take action –
escalation Process

Defects vs. errors

The are not the same thing!

- Defects are the result of error.
- Error is the cause of defects.

Why do errors occur?

- Incorrect procedures
- Excessive variation in the process
- Excessive variation in the inputs
- Inaccurate measuring devices
- Human error

5 Whys

How To Complete The 5 Whys

1. Write down the specific problem.
Writing the issue helps you formalize the problem and describe it completely. It also helps a team focus on the same problem.
2. Ask Why the problem happens and write the answer down below the problem.
3. If the answer you just provided doesn't identify the root cause of the problem that you wrote down in step 1, ask Why again and write that answer down.
4. Loop back to step 3 until the team is in agreement that the problem's root cause is identified.
Again, this may take fewer or more times than five Whys.

5 Whys Example

All processes generate defects! The defect may be caused by:

- Material – Tooling
 - Operator – Environment
 - Machine – Methods
 - Capacity
- These, however, are not the true root causes of the defect. You must ask why 5 times to get to the true root cause:

Defect!

- Why? Operator error
Why? Mislocated part
- Why? Locator was worn
- Why? Locator not heat treated
- Why? Not called out on tool drawing

6Ms Fishbone

Variables that determine whether a product is correctly manufactured.

- Men and women
- Materials
- Machines
- Methods
- Measurements
- Mother Nature (environment)

Elimination of Defects

When can we find mistakes?

- Before they occur: Prediction or prevention
- After they occur: Detection

Eliminate defects through error reduction

Poka Yoke (Error/Mistake Proofing)

What is it?

- Building error proofing mechanisms into a process to prevent or detect defects immediately
- Examples:
 - Drop down text boxes for data entry
 - Computer passwords
 - Gas pump shuts off when tank is full

Why implement?

- Ensure defects are not created, accepted, or passed
- Do it right the first time

How implement?

- Point of origin inspection
- Zero defect mentality.
- Identify root cause and take action when defects are identified
- Leverage people working the process to develop mistake proof mechanisms

Mistake Proofing Techniques

Technique	Prediction/ Prevention	Detection
Shutdown	When a mistake is about to be made	When a mistake or defect has been made
Control	Errors are impossible	Defective items can not move on to the next step
Warning	That something is about to go wrong	Immediately when something does go wrong

“It is good to do it right the first time: It is even better to make it impossible to do it wrong the first time.”

Mistake Proofing Examples

Shutdown

Prediction/prevention

Some cameras will not function when there is not enough light to take a picture.

Detection

Some laundry dryers have a device that shuts them down when overheating is detected.

Control

Prediction/prevention

When gas stations still offered leaded gasoline in addition to unleaded gasoline, the nozzle on the unleaded pump and the hole for the gas tank were smaller than that for leaded gasoline.

Detection

A fruit orchard that takes great pride in its oversized apples assures only the biggest apples get to customers by passing all apples through a sizer. Those that do not make it are sent to the discount outlet.

Mistake Proofing Examples Cont.

Warning

Prediction/prevention

Many cars have warning systems to alert the driver that not all seat belts have been fastened.

Detection

Smoke detectors provide a warning that smoke has been detected and that there is a possible fire.

QUIZ 4

1. 5 whys are used to detect the root cause of a defect

- A. True
- B. False

2. What the 6 Fishbone Ms mean

- A. Machines, Men, Mother Nature, Materials, Measurements, Methods
- B. Machines, Men, Miscellaneous, Materials, Measurements, Methods
- C. Maintenance, Men, Mother Nature, Materials, Measurements, Methods
- D. Machines, Men, Mother Nature, Materials, Measurements, Means

3. Is alarm system to alert driver that not all seat belts have been fastened a mistake proofing technique

A. True

B. False

4. Some cameras will not function when there is not enough light to take a picture, is that

- A. Control technique
- B. Shutdown technique
- C. Warning technique

Other Tools

Model Line

What is it?

- A strategically selected production line, intended to showcase deep lean concepts. A place to pilot, refine, and then transfer proven processes to other sections of the site.

Why implement?

- Deep implementation of lean principles and systems
- Other lines can learn from the model line and rapidly implement by showing to Leaders/Employees Kaizen benefit
- Insure sustainability
- Quicker deployment on other lines

Model Line Cont.

How implement?

- Leadership
- Much dedicated resource
- Clear goal setting
- Communication to all employees as declaration
-

Coaching

- Getting right direction and line design from Sensei or high skilled lean coach
- Mechanism to continue
- Periodic plant manager walk-through
- Attend the AWO every time

The model line approach can be applied to every process/operation

Supermarkets

What is it?

- Planned inventory buffer between processes that don't flow
- An aide to pull production
- Visual inventory management

Why implement?

- Ensure right part at right time in right quantity for the customer
- Visual control of overages, shortages and obsolescence
- Controlled access to inventory

How implement?

- Supermarket to mirror the line layout
- Only standard quantities for the line/right size bins
- First in/first out (FIFO) rule
- Simple/clear labeling for the stocker and picker
- Arrange parts for ease of picking and filling
- Minimize walking distance/time

Total Productive Maintenance (TPM)

What is it?

- A proactive approach for improving the effectiveness and “uptime” of equipment

Why implement?

- Increases productivity
- Extends equipment life
- Reduces machine depreciation

Principles and Tools

- TPM Card
- TPM Checklist
- Visual Management
- 5 Whys/problem solving

TPM Pillars

Equipment and process improvement

- To increase equipment effectiveness and eliminate the 6 big equipment related losses

Autonomous Maintenance

- Performed by the operators

Planned Maintenance

- To increase efficiency of traditional preventive maintenance activities

Education and Training

- To improve/raise operation and maintenance skills

Early management of new equipment

- To create equipment which requires less maintenance
- This is global approach... not only a set of tools

Pillar 1: Individual Equipment improvements to eliminate six big losses

Zero Failures

Zero Defects

Production, Maintenance, Eng Team

- Identify the six big losses
- Calculate OEE and set targets
- Analyze and address root causes
- Identify and establish optimal equipment conditions

Pillar 2: Autonomous Maintenance

Operators understand their equipment

Operators who care for their equipment

Operator Teams

- Do initial cleaning
- Make cleaning and inspection easier
- Set cleaning and lubrication standards
- Develop general inspection skills
- Conduct inspection

Pillar 3: Planned Maintenance

More efficient, cost effective maintenance operations

Maintenance Teams

- Daily and periodic maintenance and inspection
- Predictive maintenance
- Improvements to lengthen equipment life
- spare parts control
- breakdown analysis
- lubrication control

Pillar 4: Maintenance & Operation skills training

High levels of operators and maintenance workers

Operators

Maintenance Teams

- Maintenance fundamentals (equipment subsystems)
- Predictive technology
- repair skills
- Troubleshooting and diagnosis

Pillar 5: MP Design & Early Equipment management

More reliable equipment, easier to operate and maintain

Stable production right after installation

Production Design Eng

Maintenance staff

- Establish design goals
- Maintainability
- Operability
- Reliability
- Lower life cycle costing
- Anticipate and prevent production problems during design stages and debug

3P

3P is about rapidly designing product and production processes to ensure:

- - capability,
- built-in quality,
- productivity,
- and Flow-Takt-Pull.

3P minimizes resources needed such as:

- - capital,
- - tooling,
- - space,
- - inventory,
- - and time....

Rather than tweaking an existing shop floor process, start with a clean sheet of paper.

3P Cont.

3P changes the order of development

1. Machines / Equipment

2. Tooling

3. Layout/Flow

- Way of Thinking About Creating a Production Line/Cell

3P Cont. 2

3P can be applied to :

1. New products.
2. Design changes.
3. Changes in demand.
4. Process changes to facilitate lean mfg. techniques

3P simulates production line of new products at early stages of process design

GOAL: Learn about manufacturability before committing to a process flow.

QUIZ 5

Question 1

What does FIFO stands for?

Question 2

What TPM stands for?

Question 3: How many pillars we found in TPM system

- A. There is no pillars in TPM system
- B. 5
- C. 10
- D. 15

Question 4

What 3P stands for?

Question 5: The goal of 3P is A proactive approach for improving the effectiveness and “uptime” of equipment

- A. True
- B. False

Conclusion

Student Learning Objectives Conclusions

- **Understand & Identify Value vs. 7 Wastes**
Understand how a Value Stream Map is used
- **Be able to calculate Takt Time Understand and be able to identify Root Cause**
AND:
- **Understand how Lean Manufacturing impacts Business Metrics as Cycle Time & Inventory**

Waiting

Unbalanced activities ... waiting for previous process

- Increases lead time
- Increases work in process
- Slows response to customer

Improvement ideas:

- Eliminate redundancies
- Establish Single piece flow
- Eliminate hand-offs
- Balance operations / processing steps

Examples:

- Waiting for shared equipment
- Waiting for decisions (dispositions, inspection , materials...)
- Unnecessary approvals
- System downtime
- Response times
- Information awaiting on overnight 'systems batch run'

Inventory

Holding extra material on shelves, racks, and floors

Typical causes:

- Push production
- Over- ordering
- Too much floor space
- Too many shelves

Improvement ideas:

- Reduce times
- Establish signal (kanban) system
- Examples:
 - Multiple credit applications waiting for approval
 - Long queues in service operations
 - Unnecessary document / data storage
 - Large deposits of material at each operation, on shelves, racks, & floors
 - Large delivery quantities instead of frequent deliveries (in or out)

Defects

Defective work or excessively checking work

- Upsets customers
- Consumes resources
- Chokes flow

Typical causes:

- Variation in processes
- Collecting unnecessary inspection data

Improvement ideas:

- Poke Yoke (Mistake Proofing)
- Jidoka (Autonomation)
- Cross training
- Document procedures
- Establish information needs
- Examples:
 - Customer data (or other information) incorrect or incomplete
 - Missed customer due date / spec limit
 - Data entry errors
 - Rework

Extra Processing

Unnecessary or non-value adding activities

- Create delay
- Increase opportunity for more defects
- Don't add value by definition

Typical causes:

- Work is not standardized
- Tasks are not simplified
- Procedures are not understood

Improvement ideas:

- Automate the process
- Eliminate non-value adding steps
- Combine steps/forms

Examples:

- Unnecessary approvals
- Checking someone else's work, excessive reviews
- Processing beyond specification limits or customer requirements
- Unnecessary record retention
- Multiple ways to do the same thing

Transportation

- Creating parts ahead of schedule (vs. just-in-time)
 - Ties up working capital
 - Takes up floor space
 - Hides process problems (bad quality, poor scheduling, poor delivery)
- Typical causes:
 - Production schedules & push production
 - Cost justification for expensive equipment
 - Working on the wrong parts at the wrong time
- Improvement ideas:
 - Reduce time and order quantity
 - Level out the orders
 - Remove all unnecessary paperwork
 - Improve quality
- Examples:
 - Processing before next operation is ready
 - Processing prior to need
 - Making decisions too early
 - Generating more information (reports, paper) than required

Motion

- Motion that does not add value to the process
- Typical causes:
 - Equipment/Office layout
 - Product Design
 - Material, Inventory storage
- Improvement ideas:
 - Implement point of use
 - Develop work cells
- Examples:
 - Walking to collect copies from printer
 - Commuting between sites
 - Navigating multiple screens to input data
 - Looking for data / information