Lean Manufacturing

Outline

1. Lean Manufacturing
2. 5S & Visual Controls
3. Kaizen
4. Value Streams
5. Pull Manufacturing
6. Mistake Proofing
7. Quick Changeover
8. Six Sigma
9. Lean Accounting
10. Theory of Constraints
11. Human Factors

Lean Manufacturing

Definitions

- **Value** **-** A capability provided to a customer at the right time at an appropriate price, as defined in each case by the customer. Features of the product or service, availability, cost and performance are dimensions of value.

- **Waste** **-** Any activity that consumes resources but creates no value (waste).

What is Lean?

- Lean production focuses on eliminating waste in processes (i.e. the waste of work in progress and finished good inventories)
- Lean production is not about eliminating people
- Lean production is about expanding capacity by reducing costs and shortening cycle times between order and ship date
- Lean is about understanding what is important to the customer

Thinking Lean

- Specify value
  - can only be defined by the ultimate customer
- Identify the value stream
  - exposes the enormous amounts of waste
- Create flow
  - reduce batch size and WIP
- Let the customer pull product through the value stream
  - make only what the customer has ordered
- Seek perfection
  - continuously improve quality and eliminate waste

From Lean Thinking by Womack and Jones

Benefits

- Lean provides tangible benefits
- Reduces costs not just selling price
  - Reduces delivery time, cycle time, set-up time
  - Eliminates waste
  - Seeks continuous improvement
- Improves quality
- Improves customer ratings and perceptions
- Increases overall customer satisfaction
- Improves employee involvement, morale, and company culture
- Helps “transform” manufacturers

Toyota Production System (TPS)

- Quality, Cost, Delivery
  - Shorten Production Flow by Eliminating Waste
- Just In Time
  - The Right Part at the Right Time in the Right Amount
  - Continuous Flow
  - Pull Systems
  - Level Production
- Built-In Quality
  - Error Proofing – Poka Yoke
  - Visual Controls
- Operational Stability
  - Standardized Work
  - Robust Products & Processes
  - Total Productive Maintenance
  - Supplier Involvement

Types of Waste

- Overproduction
- Excess inventory
- Defects
- Non-value added processing
- Waiting
- Underutilized people
- Excess motion
- Transportation

Lean vs. Traditional Manufacturing

- Half the hours of engineering effort
- Half the product development time
- Half the investment in machinery, tools and equipment
- Half the hours of human effort in the factory
- Half the defects in the finished product
- Half the factory space for the same output
- A tenth or less of in-process inventories

Lean vs. Traditional Manufacturing

- 99.9% Customer Schedule Attainment
- Defects of 15 PPM or less
- 4-6 Inventory Days of Supply
- 92%+ Operational Availability
- Leveled, Sequenced Production
- Order to Customer Use - Hours, not weeks
- Functioning Supplier Partnership
- Strong Production Control Function

Examples: Tier 1 Suppliers: Johnson Controls Seating, Litens Automotive Partnership, Cadimex, Denso Manufacturing, Toyota Motor Corporation.

Barriers to Lean

- Implementing Lean Can Be Difficult Because it is Counterintuitive from a Traditional Paradigm:
  - Buying multiple small machines rather than one big machine that offers economies of scale.
  - Shutting down equipment when maximum inventory levels are reached rather than running flat out.
  - Using standards to continuously improve.
- There is no step-by-step cook book
  - There are some basic steps but the how-to varies from organization to organization
  - Requires an assessment of the company in order to map out the strategy
- Company culture plays a big part in the how-to

Implementing Lean

- Gain top Management "Buy In" and Support
- Perform overall company assessment tied to company strategic, operational, and marketing plans
- Develop strategic lean deployment plan
- Integrate customized training with lean to improve specific skill sets, leverage training resources
- Team Building, Communications, Problem Solving, Change Management, Lean Manufacturing Tools
- Conduct "Kaizen blitz" high impact events
- 5S, Manufacturing Cell, Set-Up Reductions, Inventory Reductions, Work Standardization
- Use an enterprise wide approach to help "Transform" a client's culture and the way they do business.

Progress Toward Lean

- Smaller lot sizes
- Increased capacity / throughput
- Higher inventory turns
- More available floor space
- Improved workplace organization
- Improved quality : reduced scrap / re-work
- Reduced inventories : raw, WIP, FG
- Reduced lead times
- Greater gross margin
- Improved participation & morale

Lean Is A Journey

- The Journey never ends
- Toyota estimates it is only 50% waste-free

- Where can we begin? Where can we improve?

5S & Visual Control

5S and Visual Control

- 5 Elements of 5S
- Why 5S?
- Waste
- Workplace observation
- **Sort**
- **Straighten**
- **Shine**
- **Standardize**
- **Sustain**
- Visual Factory

5 Elements of 5S

- **Sort**
- **Straighten**
- **Shine**
- **Standardize**
- **Sustain**

Why 5S?

- To eliminate the wastes that result from “uncontrolled” processes.
- To gain control on equipment, material & inventory placement and position.
- Apply Control Techniques to Eliminate Erosion of Improvements.
- Standardize Improvements for Maintenance of Critical Process Parameters.

Types of Waste

- Overproduction
- Delays (waiting)
- Transportation
- Process
- Inventories
- Motions
- Defective Products
- Untapped Resources
- Misused Resources

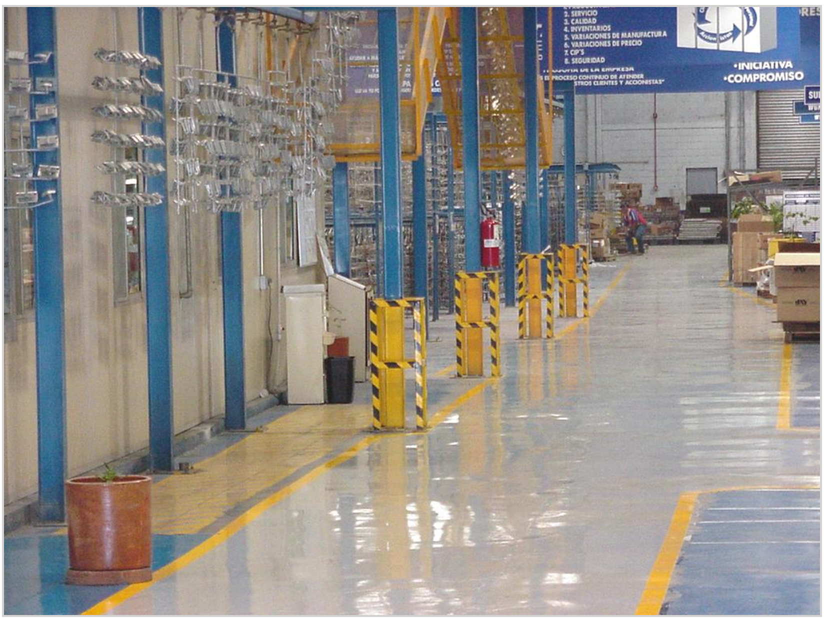
Elimination of Waste

Waste Identification

- What waste can be identified in the following photos?

After 5S

- Clear, shiny aisles
- Color-coded areas
- Slogans & banners
- No work in process



Workplace Observation

- Clearly define target area
- Identify purpose and function of target area
- Develop area map
- Show material, people, equipment flow
- Perform scan diagnostic
- Photograph problem areas
- Develop a project display board (area)

Sort

- When in doubt, move it out
- Prepare red tags
- Attach red tags to unneeded items
- Remove red-tagged items to “dinosaur burial ground”
- Evaluate / disposition of red-tagged items

Straighten

- Make it obvious where things belong
  - Lines
    - Divider lines
    - Outlines
    - Limit lines (height, minimum/maximum)
    - Arrows show direction
  - Labels
    - Color coding
    - Item location
  - Signs
    - Equipment related information
    - Show location, type, quantity, etc.

Shine

- Clean everything, inside and out
- Inspect through cleaning
- Prevent dirt, and contamination from reoccurring

  - Results in
    - Fewer breakdowns
    - Greater safety
    - Product quality
    - More satisfying work environment

Standardize

- Establish guidelines for the team 5-S conditions
- Make the standards and 5-S guidelines visual
- Maintain and monitor those conditions

Sustain

Determine the methods your team will use to maintain adherence to the standards

- 5-S concept training
- 5-S communication board
- Before and after photos
- One point lesson
- Visual standards and procedures
- Daily 5-minute 5-S activities
- Weekly 5-S application

Visual Factory Implementation

- Develop a map identifying the "access ways"(aisles, entrances, walkways etc.) and the "action" areas.
- Perform any necessary realignment of walkways, aisles, entrances.
- Assign an address to each of the major action areas.
- Mark off the walkways, aisles & entrances from the action areas
- Apply flow-direction arrows to aisles & walkways
- Perform any necessary realignment of action areas.
- Mark-off the inventory locations
- Mark-off equipment/machine locations
- Mark-off storage locations (cabinets, shelves, tables)
- Color-code the floors and respective action areas

Kaizen

What is Kaizen?

- Kaizen (Ky’zen)
- “Kai” means “change”
- “zen” means “good (for the better)”
- Gradual, orderly, and continuous improvement
- Ongoing improvement involving everyone

How to Kaizen

- Identify the customer
- Deming Cycle
  - Plan – identify what to change and how to do it
    - Current state
    - Future state
    - Implementation plan
  - Do – execute the improvement
  - Check – ensure the improvement works
  - Act – future and ongoing improvements
  - Repeat

Identify the Customer

- Value added is always determined from the customer's perspective.
- Who is the customer?
- Every process should be focused on adding value to the customer.
- Anything that does not add value is waste.
- Some non-valued added activity is necessary waste ("NVA-R")
  - Regulatory
  - Legal

Types of Waste

- Overproduction
- Excess inventory
- Defects
- Non-value added processing
- Waiting
- Underutilized people
- Excess motion
- Transportation

Identify the Current State

- Crucial first step in process improvement
- Deep understanding of the existing processes and dependencies
- Identify all the activities currently involved in developing a new product
- Observe the process first hand
- Identify Value Added (VA), Non-Value Added Required (NVA-R), and Non-Value Added (NVA)
- Generally creates more questions than answers

Brainstorm and Analyze

- Kaizen team brainstorming to develop new process
- Post improvement ideas on map or by category
  - Workflow
  - Technology
  - People / Organization
  - Procedures
- Develop detailed future state map
  - New workflow
  - Value Add and Non-Value Add
  - Cycle times
  - Identify Kaizen “bursts” (immediate radical change)

Implementation Plan

- Think global / systems optimization
- Maximum impact to process
- Speed of implementation – create small victories
- Cost-benefit analysis

Execute

- Develop a concise, achievable milestone plan
- Communicate the plan to everyone
  - Suppliers
  - Team members
  - Customers
- Track activities in public
- Celebrate small victories and publicly analyze failures

Check and Sustain

- Meet regularly (weekly?) to review status of open implementation items
- Re-evaluate Future State regularly (quarterly?) for additional improvement
- Track results on a public Kaizen Board

Kaizen Blitz

- Total focus on a defined process to create radical improvement in a short period of time
- Dramatic improvements in productivity, quality, delivery, lead-time, set-up time, space utilization, work in process, workplace organization
- Typically five days (one week) long

Kaizen Blitz - Agenda

- Day 1: Setting the scene
  - Meet the team, training
- Day 2: Observe the current process
  - Flowchart, identify waste, identify root causes
- Day 3: Develop the future state process
  - Brainstorm and flowchart (typically the longest day!)
- Day 4: Implement the new process
  - Plan, communicate, implement, modify
- Day 5: Report and analyze
  - Performance vs expectations

Roadblocks

- Too busy to study it
- A good idea but the timing is premature
- Not in the budget
- Theory is different from practice
- Isn’t there something else for you to do?
- Doesn’t match corporate policy
- Not our business – let someone else analyze it
- It’s not improvement – it’s common sense
- I know the result even if we don’t do it
- Fear of accountability
- Isn’t there an even better way?

Value Streams

Outline

- What are Value Streams?
- Identifying the Value Streams
- Value Stream Mapping
- The Current State
- The Future State
- Implementing Change
- Roadblocks

What Are Value Streams?

A Value Stream *is the set of all actions (both value added and non value added) required to bring a specific product or service from raw material through to the customer.*

Types of Value Streams

"Whenever there is a product (or service) for a customer, there is a value stream. The challenge lies in seeing it."

- 3 enterprise value streams:
  - Raw Materials to Customer - Manufacturing
  - Concept to Launch - Engineering
  - Order to Cash - Administrative Functions

Identifying the Value Stream

- The starting point is to learn to distinguish value creation from waste in your whole value stream
- By putting on waste glasses!
- By choosing a product family
- By assembling the team and taking a walk together up the value stream
- And drawing a map of what you find!

Value Stream Mapping

- Helps you visualize more than the single process level
- Links the material and information flows
- Provides a common language
- Provides a blueprint for implementation
- More useful than quantitative tools
- Ties together lean concepts and techniques

Value Stream Mapping

- Follow a “product” or “service” from beginning to end, and draw a visual representation of every process in the material & information flow.
- Then, draw (using icons) a “future state” map of how value should flow.

The Current State

Typical Steps to Complete a Current State Drawing

- Document customer information
- Complete a quick walk through to identify the main processes (i.e., how many process boxes)
- Fill in data boxes, draw inventory triangles, and count inventory
- Document supplier information
- Establish information flow: how does each process know what to make next?
- Identify where material is being pushed
- Quantify production lead time vs. processing time

The Current State

- Where and how large are the inventories in the physical flow?

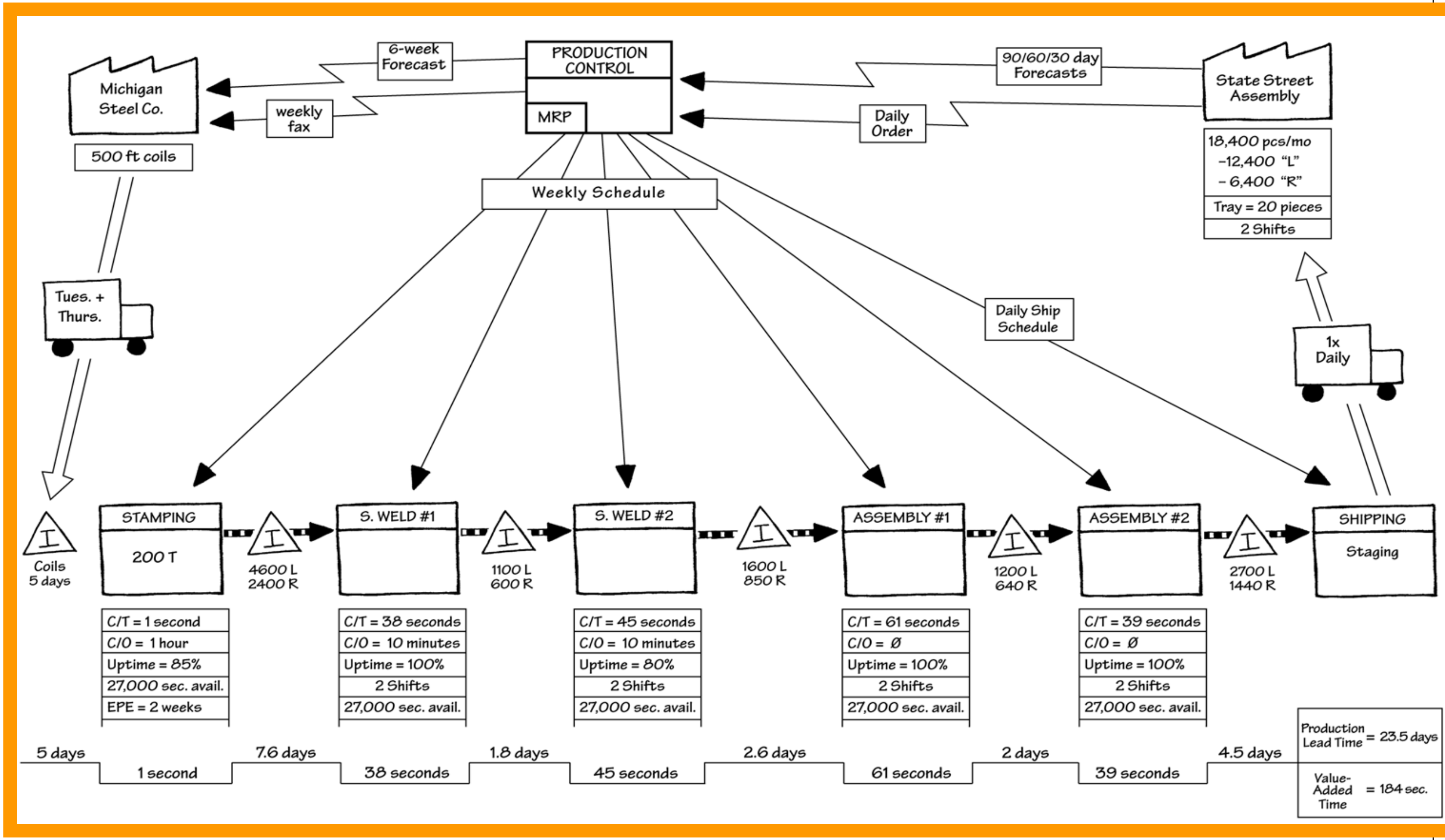
  Hint: Carefully distinguish buffer stocks, safety stocks, and shipping stocks. Then determine "standard inventory" for current system design and capabilities.

The Current State

- How reliable is each transport link (on-time delivery percentage) and how many expediting trips per year are needed?

  Note: By multiplying quality data from by on-time delivery data you can calculate the “fulfillment level” each facility as perceived by the next downstream customer. The is a key measure from a total value stream perspective.

The Current State



The Future State

- Completed in a day with the same team
- Focused on:
  - Creating a flexible, reactive system that quickly adapts to changing customer needs
  - Eliminating waste
  - Creating flow
  - Producing on demand

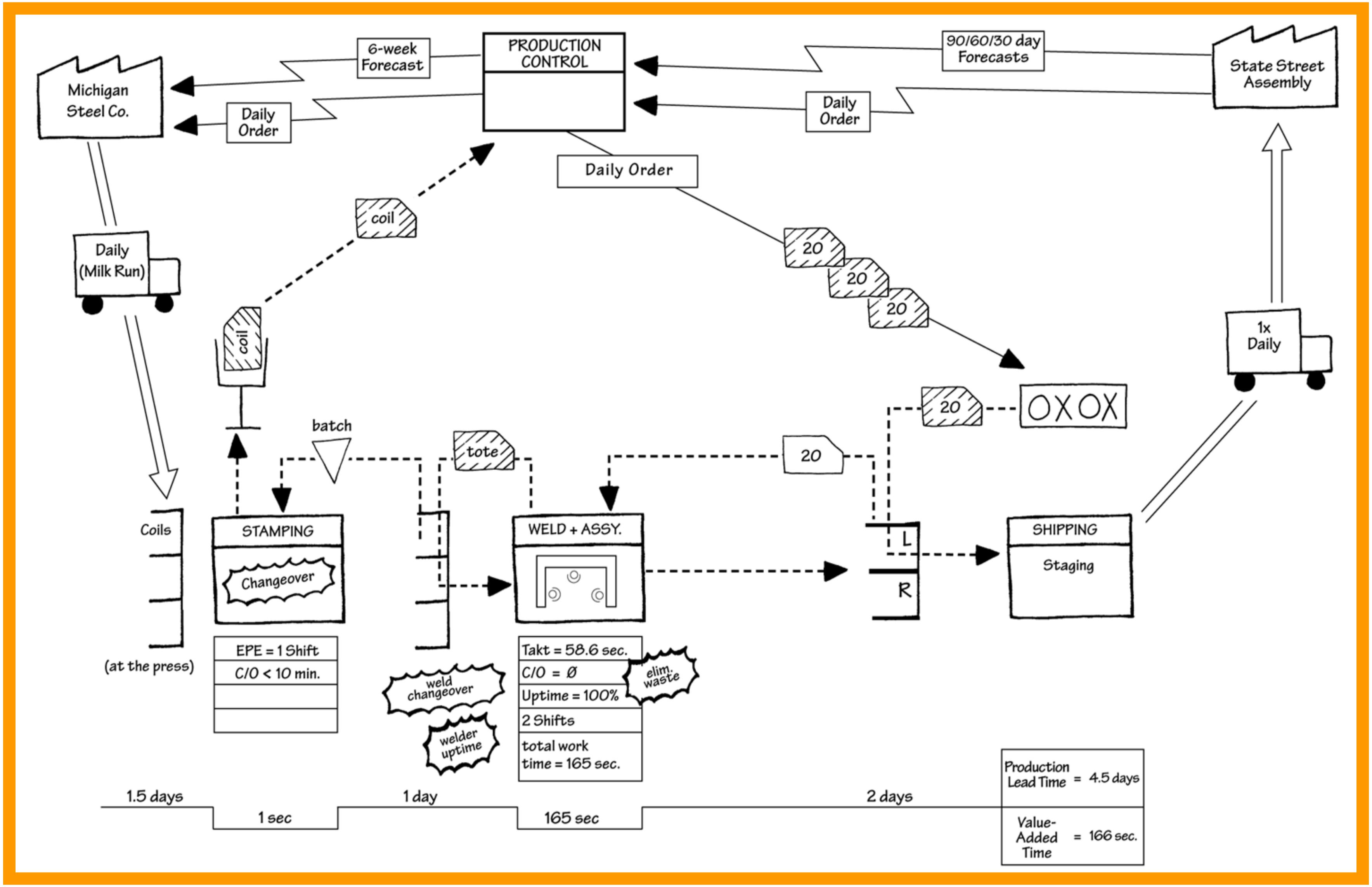
The Current State

- Typical Results
  - 80 – 90% of total steps are waste from standpoint of end customer.
  - 99.9% of throughput time is wasted time.
  - Demand becomes more and more erratic as it moves upstream, imposing major inventory, capacity, and management costs at every level.
  - Quality becomes worse and worse as we move upstream, imposing major costs downstream.
  - Most managers and many production associates expend the majority of their efforts on hand-offs, work-arounds, and logistical complexity.

The Future State

- Activities aligned with our business strategy
- Efforts focused on NET improvements for the company
- Metrics supportive of fundamental change
- Simple, constant communication of our plans and achievements as an enterprise

The Future State



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Implementing Change

Don't Wait!

You need a plan!

- Tie it to your business objectives.
- Make a VS Plan: What to do by when.
- Establish an appropriate review frequency.
- Conduct VS Reviews walking the flow.

Implementing Change

- Critical Success Factors
  - Management must understand, embrace, and lead the organization into lean thinking
  - Value stream managers must be empowered and enabled to manage implementations
  - Improvements must be planned in detail with the cross functional Kaizen teams
  - Successes must be translated to the bottom line and/or market share

Implementing Change

Each Value Stream needs a Value Stream Manager

Process 1 → Process 2 → Process 3 → "Customer"

Kaizen

The Value
Stream Manager

The conductor of implementation:

- Focused on system wins
- Reports to the top dog

Implementing Change

Typical Results

- Throughput time falls from 44 days to 6 (87%)
- Wasted steps fall from 65 to 27 (60%)
- Transport distance falls from 5300 miles to 1100 miles
- Demand amplification is reduced from 20% to 5%
- Inventories shrink by 90% percent
- Defects are reduced to the same rate at the start of the process as at the end
- Throughput time shrinks to within customer wait time, meaning all production is to confirmed order

Roadblocks

- 75 years of bad habits
- Financial focus with limited cost understanding
- A lack of system thinking and incentives
- Metrics supporting a 75 year old model
- Limited customer focus
- Absence of effective operating strategies

Roadblocks

- Traditional approaches do not focus on the value stream
  - Create “perfect competition” at the next level of supply upstream, by attracting many bidders.
  - Improve bargaining power through scale economies in raw materials buys as well.
  - Turn up the competitive pressure with reverse auctions where possible.
  - Demand continuing price reductions in multi-year contracts whatever happens to volume.
  - Note the lack of process analysis of the value stream!
  - “Market will insure lowest costs & highest efficiency!”

Roadblocks

- Margin squeezing rather than true cost reduction.
- Persistent shortfalls in quality and delivery reliability.
- Low-ball bidding and the engineering change game.
- Collapse of “partnership” and “trust” in economic downturns (2001!), replaced by “survival of the fittest”.

Wrong Ways to Address Roadblocks

- Programs of the month (band aids)
- Meetings, meetings, meetings, meetings
- Silo optimization

Pull Manufacturing

Outline

- Why Pull Manufacturing?
- The Problem of Inventory
- Just In Time
- Kanban
- One Piece Flow
- Demand / Pull
- Standard Work & Takt Time
- Production Smoothing

Why Pull Manufacturing?

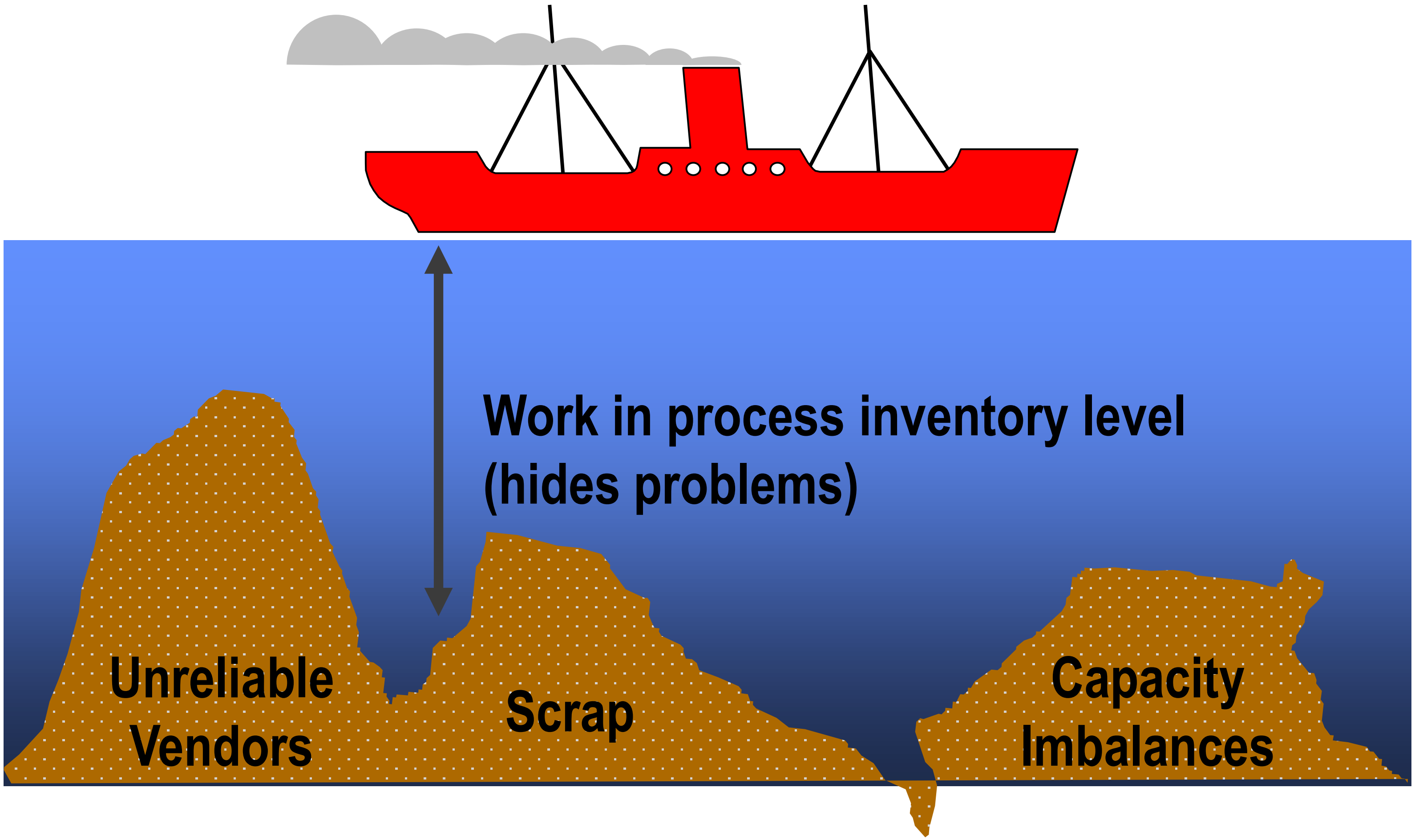
Lean manufacturing is really about minimizing the need for overhead

- which is about concentrating precisely on *only* what is necessary
- which is about linking interdependent supply system decisions, and actions
- which needs to be visual, responsive and simple to manage

Push Vs. Pull Scheduling

- Push Scheduling
  - traditional approach
  - "move the job on when finished"
  - problems - creates excessive inventory
- Pull scheduling
  - coordinated production
  - driven by demand (pulled through system)
  - extensive use of visual triggers (production/withdrawal kanbans)

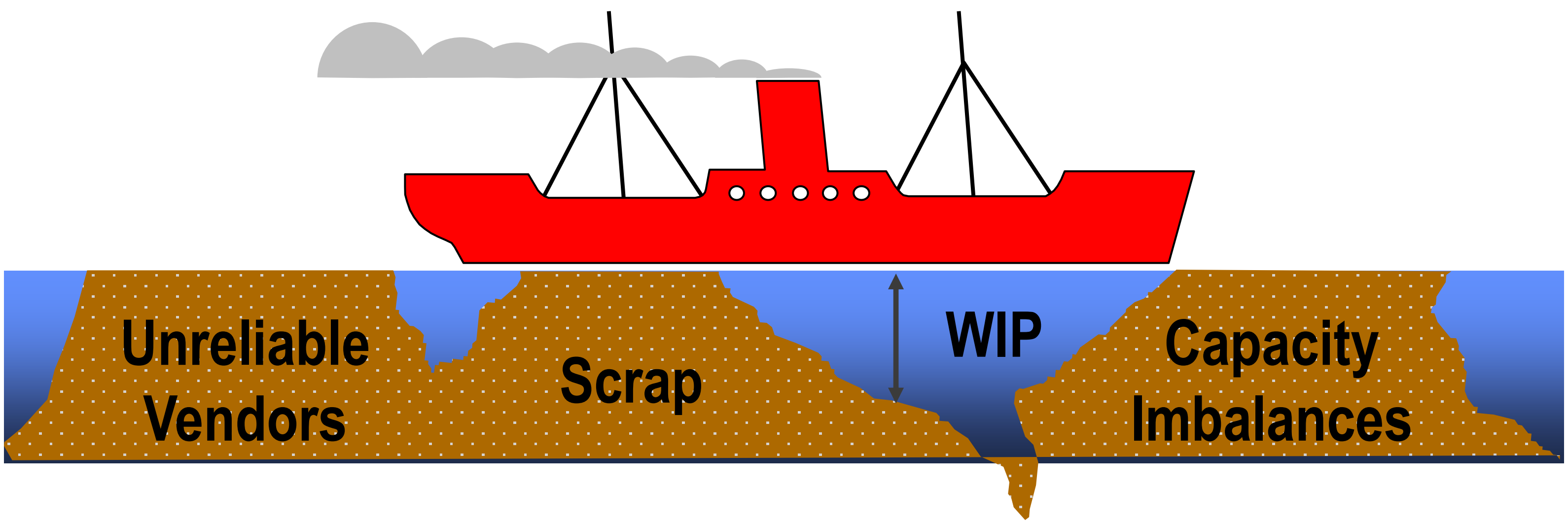
Inventory Hides Problems



Lowering Inventory Reveals Problems

Accommodate lower inventory levels by:

- Reducing variability
- Eliminating waste
- Streamlining production and material flows
- Accurate information



What is Just-in-Time?

- Management philosophy of continuous and forced problem solving (forced by driving inventory out of the production system)
- Supplies and components are ‘pulled’ through system to arrive where they are needed when they are needed.

Goal: Achieve the minimal level of resources required to add the necessary value in the production system.

Objective of JIT

- Produce only the products the customer wants
- Produce products only at the rate that the customer wants them
- Produce with perfect quality
- Produce with minimum lead time
- Produce products with only those features the customer wants

JIT Principles

- Create flow production
  - one piece flow
  - machines in order of processes
  - small and inexpensive equipment
  - U cell layout, counter clockwise
  - multi-process handling workers
  - easy moving/standing operations
  - standard operations defined

Quality enables JIT

- Processes are easy to understand—visible
- Quality issues are apparent immediately
- Scope of problems are limited because of lower inventory levels
- TQM management methods are very important

Quality of execution typically determines how low inventories can be reduced!

How to accomplish JIT production

1) Design Flow Process
- -Link operations
- -Balance workstation capacities
- -Re-layout for flow
- -Emphasize preventive maintenance
- -Reduce lot size
- -Reduce setup/changeover time

2) Total Quality Control
- -Worker responsibility
- -Measure: SQC
- -Enforce compliance
- -Fail-safe methods
- -Automatic inspection

3) Stabilize Schedule
- -Level schedule
- -Underutilize capacity
- -Establish freeze windows

4) Kanban Pull
- -Demand pull
- -Backflush
- -Reduce lot sizes

5) Work with Vendors
- -Reduce lead times
- -Frequent deliveries
- -Project usage requirements
- -Quality expectations

6) Reduce Inventory More
- -Look for other areas
- -Stores
- -Transit
- -Carousels
- -Conveyors

7) Improve Product Design
- -Standard product configuration
- -Standardize and reduce number of parts
- -Process design with product design
- -Quality expectations

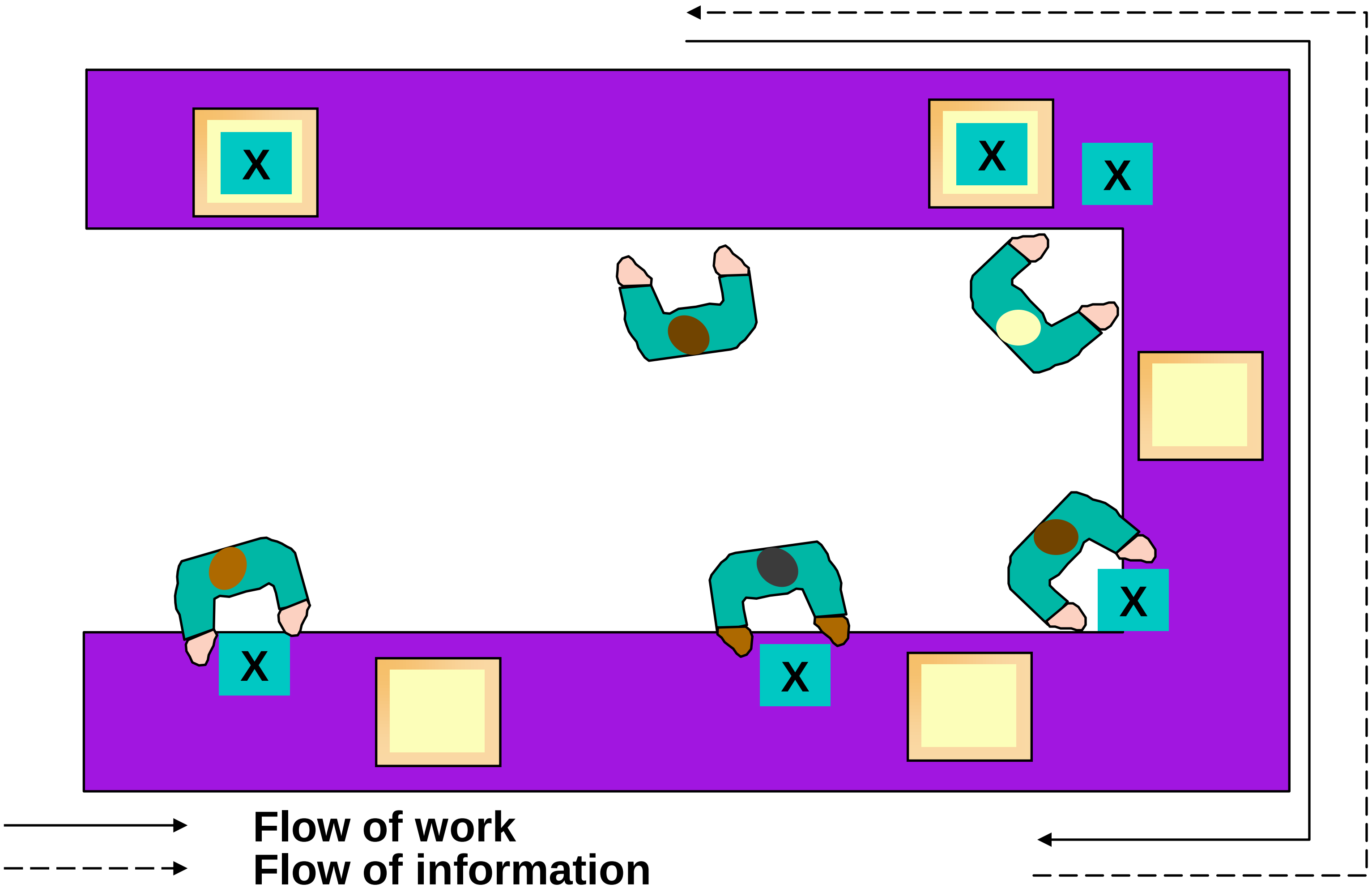
Concurrently Solve Problems
- -Root Cause
- -Solve permanently
- -Team approach
- -Line and specialist responsibiity
- -Continual education

Measure Performance
- -Emphasize improvement
- -Track trends

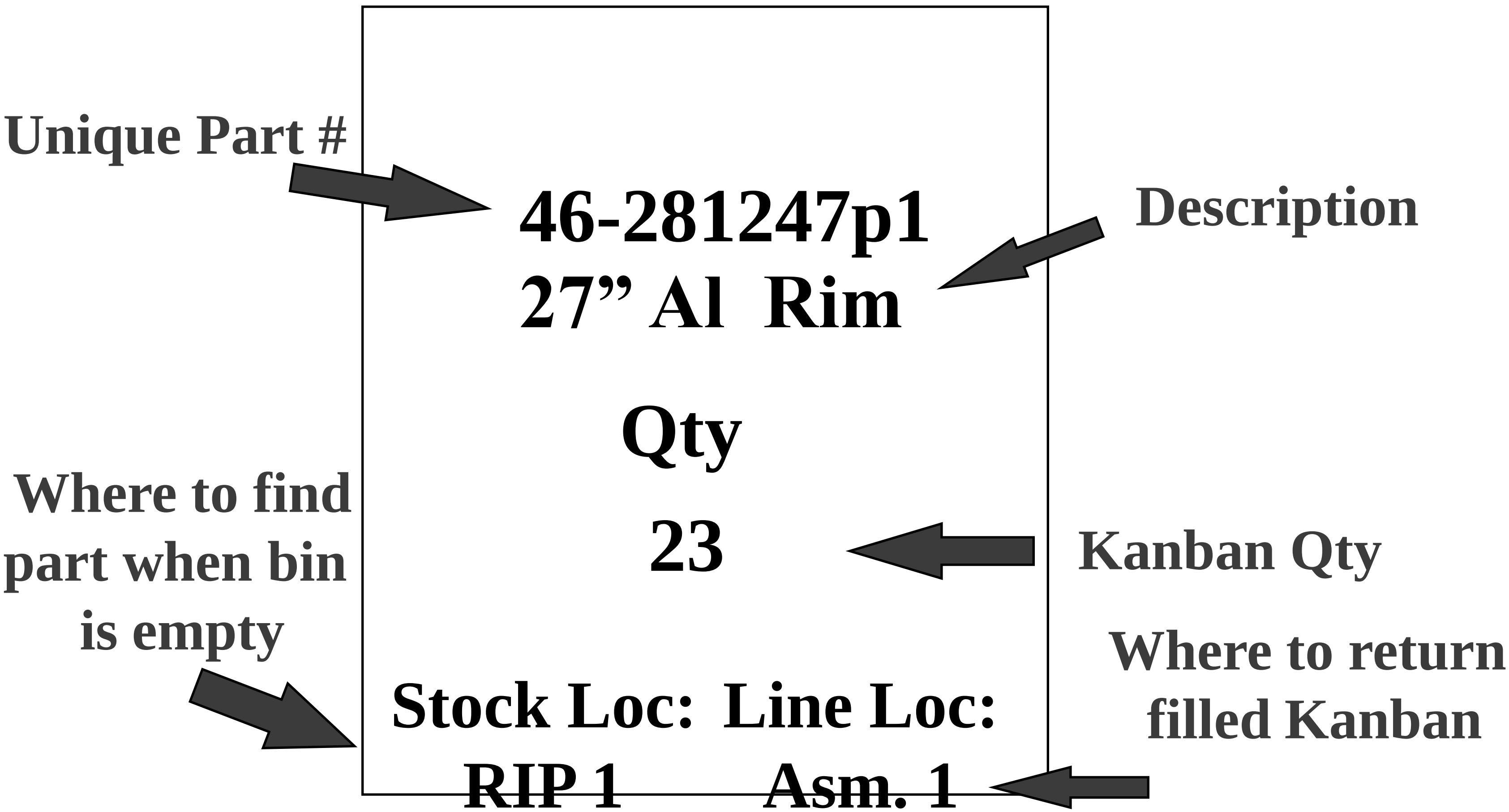
Kanban

- Japanese word for card
- Authorizes production from downstream operations based on physical consumption
- May be a card, flag, verbal signal, etc.
- Used often with fixed-size containers
- Kanban quantities are a function of lead-time and consumption rate of the item being replenished (min qty=(demand during lead-time + safety stock)/ container quantity)

Kanban Squares



Kanban Card


Unique Part #
46-281247p1
27” Al Rim
Description
Qty
23
Kanban Qty
Where to find part when bin is empty
Where to return filled Kanban
Stock Loc:
RIP 1
Line Loc:
Asm. 1

Quality at the Source

- For JIT & Kanban to work, quality must be high
  - **There can be no extra inventory to buffer against the production or use of defective units**
- Producing poor-quality items, and reworking or rejecting them is wasteful
- The workers must be responsible for inspection & production quality
- *The philosophy is, "**NEVER*** **pass along defective item**"

One Piece Flow

- A philosophy that rejects batch, lot or mass processing as wasteful.
- States that product should move (flow) from operation to operation, only when it is needed, in the smallest increment.
- One piece is the ultimate (one-piece-flow)

Continuous Flow

- Line up all of the steps that truly create value so they occur in a rapid sequence
- Require that every step in the process be:
  - Capable – right every time (6 Sigma)
  - Available – always able to run (TPM)
  - Adequate – with capacity to avoid bottlenecks (right-sized tools)

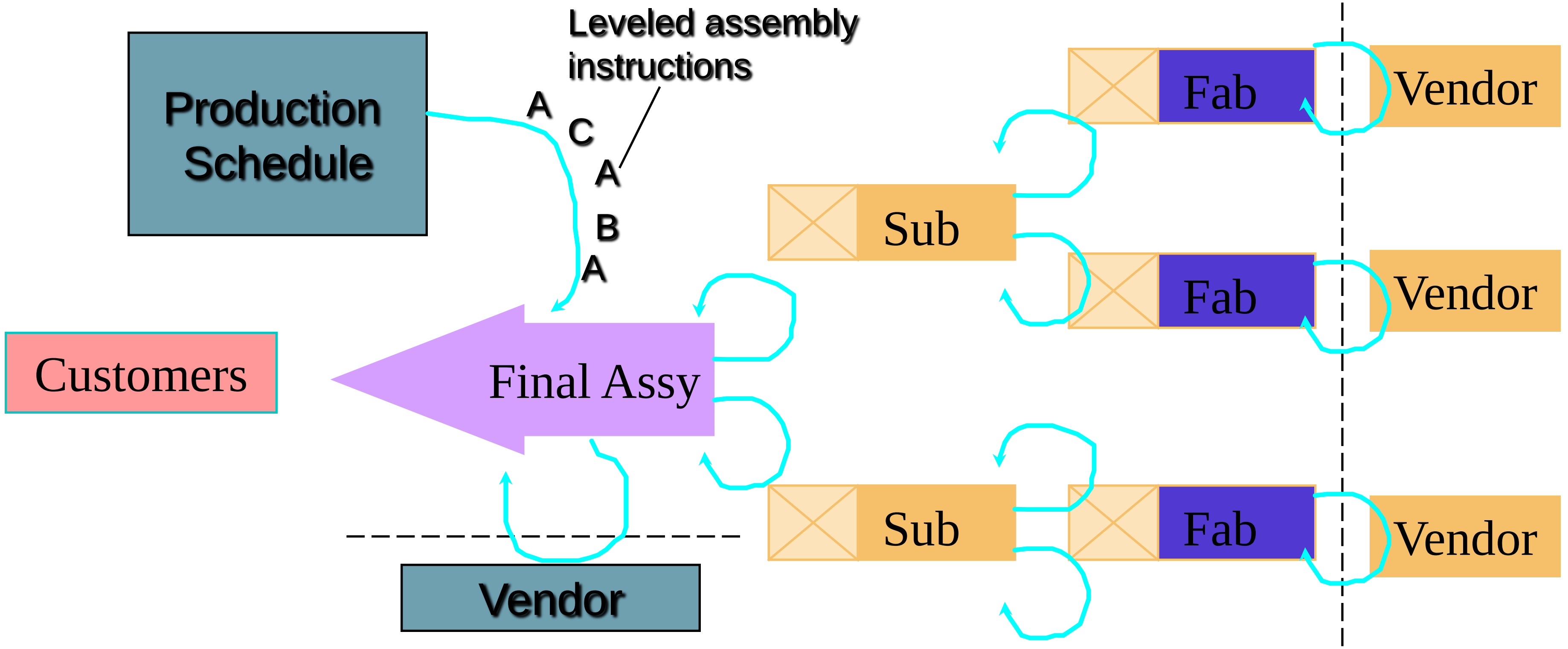
Pull Production

- Actual customer demand drives the manufacturing process.
- It creates a system of cascading production and delivery instructions from downstream demand to upstream production in which nothing is produced by the upstream supplier until the downstream customer signals a need.
- The rate of production for each product is equal to the rate of customer consumption.

Pull Production

- Through lead time compression & correct value specification, let customers get exactly what's wanted exactly when it's wanted:
  - For the short term: Smooth pull loops to reduce inventory
  - For the near term: Make-to-order with rapid response time
  - For the long term: Diagnostics and prognostics in a stable relationship to take out the surprises for consumers and producers

Pull System



Production Schedule
Leveled assembly instructions
A
C
A
B
A
Customers
Final Assy
Vendor
Sub
Sub
Fab
Fab
Fab
Fab
Vendor
Vendor
Vendor
Vendor

Standardized Work

- Standardized work consists of three elements:
  - Takt time

    Matches the time to produce a part or finished product with the rate of sales. It is the basis for determining workforce size and work allocation.
  - Standard in-process inventory

    The minimum number of parts, including units in machines, required to keep a cell or process moving.
  - Standard work sequence

    The order in which a worker performs tasks for various processes.
- Once a standard work is set, performance is measured and continuously improved

Work Balancing / TAKT Time

- Work balancing maximizes operator efficiency by matching work content to TAKT time
- TAKT time is the rate at which customers require your product
- TAKT time is calculated as follows:

$$\frac{\text{Available work time per day}}{\text{Daily required customer demand in parts per day}}$$

Production Smoothing / Leveling

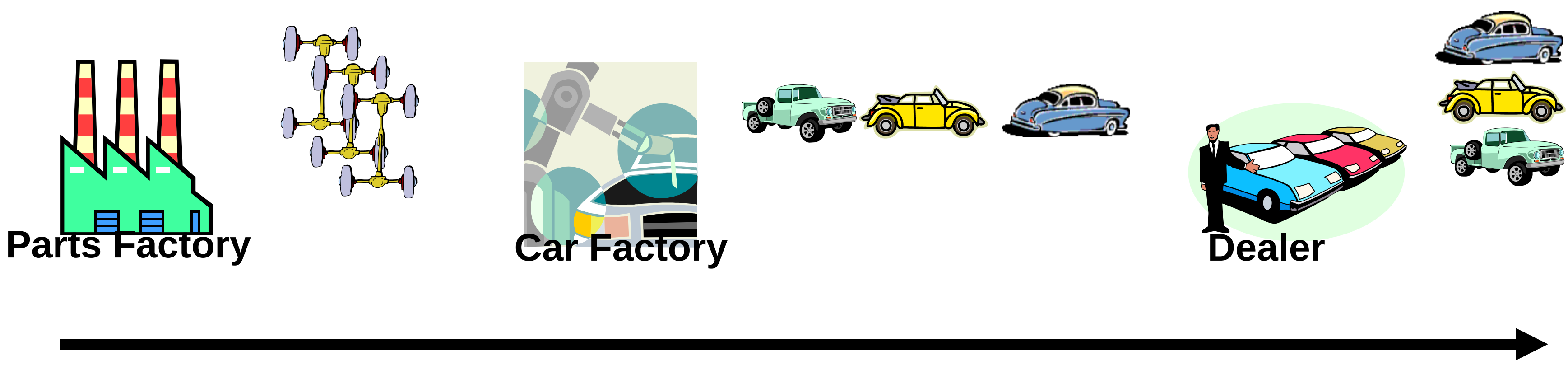
- Averaging both the volume and the production sequence of different model types on a mixed-model production line.

- Example: Toyota Manufacturing
  Toyota makes 3 car models - a convertible, hardtop, and an SUV. Assume that customers are buying nine convertibles, nine hardtops, and nine SUVs each day. What is the most-efficient way to make those cars?

Production Smoothing / Leveling

Leveling production also helps to avoid the problem of excess inventory of finished vehicles. The vehicle plants make the different types of cars at about the same pace that customers buy those cars. They can adjust the pace of production as buying patterns change.

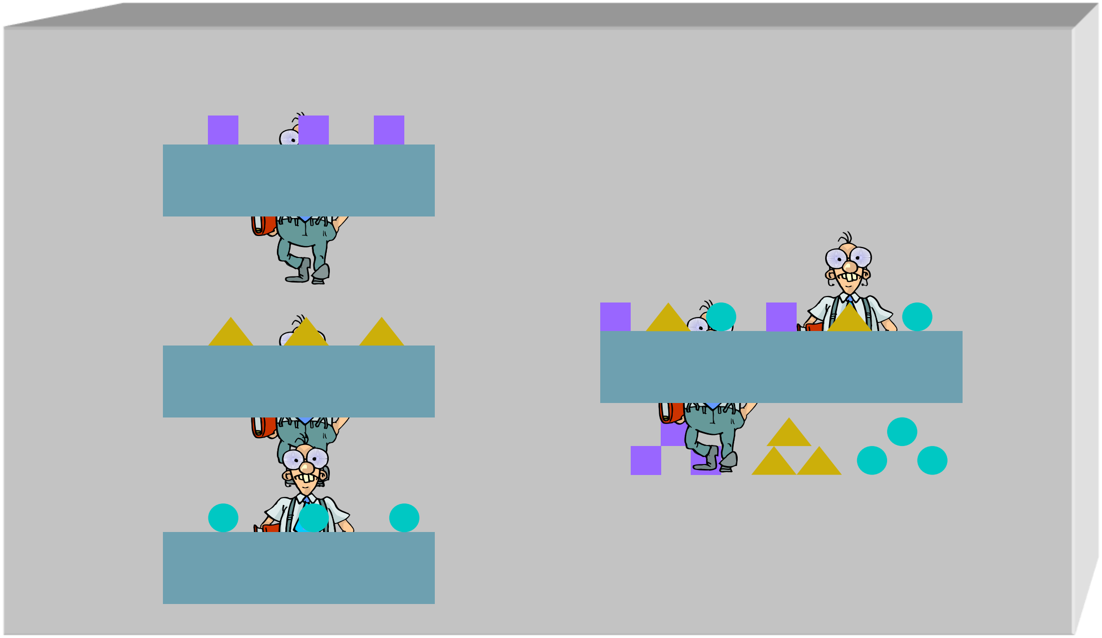
As the result, dealers only need to maintain a minimal inventory of cars to show and sell.



Production Smoothing / Leveling

Toyota solved the problem by production leveling.

If customers are buying nine convertibles, nine hardtops, and nine SUVs each day, Toyota assembles three of each in the morning, three of each in the afternoon, and three of each in the evening. It also distributes the production of convertibles, hard tops, and SUVs as evenly as possible through each shift: convertible, hard top, SUV, convertible, hard top, SUV, and so on.



Wrap-up - Pull Manufacturing

Lean manufacturing is really about minimizing the need for overhead

- which is about concentrating precisely on *only* what is necessary
- which is about linking interdependent supply system decisions, and actions
- which needs to be visual, responsive and simple to manage

Mistake Proofing

(Poka Yoke and Error Proofing)

Outline

- What is Mistake Proofing?
- Everyday Examples
- Effectiveness
- Error Proofing and SPC
- Inspection Techniques
- Types of Poka Yokes

What is Mistake Proofing?

- The use of process or design features to prevent errors or their negative impact.
- Also known as ***Poka yoke****,* Japanese slang for “avoiding inadvertent errors” which was formalized by Shigeo Shingo.
- Inexpensive.
- Very effective.
- Based on simplicity and ingenuity.

Everyday Examples

3.5 inch diskettes cannot be inserted unless diskette is oriented correctly. This is as far as a disk can be inserted upside-down. The beveled corner of the diskette along with the fact that the diskette is not square, prohibit incorrect orientation.

Fueling area of car has three error-proofing devices:

1. insert keeps leaded-fuel nozzle from being inserted
2. tether does not allow loss of gas cap
3. gas cap has ratchet to signal proper tightness and prevent overtightening.

New lawn mowers are required to have a safety bar on the handle that must be pulled back in order to start the engine. If you let go of the safety bar, the mower blade stops in 3 seconds or less.

Evidence of the Effectiveness

- **AT&T Power Systems** is first US manufacturer to win the Deming prize. Average outgoing defects reduced by 70%.
- A washing machine drain pipe assembly line produced 180,000 units without a single defect (6 months).
- **TRW** reduced customer PPM's from 288 to 2.
- **Federal Mogul:** 99.6% less customer defects and 60% productivity increase
- **DE-STA-CO**: reduced omitted parts 800 to 10 ppm with a 15-30% productivity increase.

Source: Productivity Inc. and Shingo prize profiles

Mistake Proofing ROI

- **Dana** corporation has reported a $500,000 savings resulting from a $6 device.
- **Ortho-Clinical Diagnostics (Johnson & Johnson)** saved $75000 annually by discovering a new use of Post-It® notes.
- **AT&T Power Systems** (Lucent Technologies) reported net saving of $2545 per device (3300 devices).
- **Weber Aircraft** reports saving $350,000 during their first year of implementation of approximately 300 devices.
- **GE Aircraft Engines** spends a minimum of $500,000 on any in-flight shut-down (IFSD). Spending $10,000 to stop one IFSD yields 50:1 benefit.

1-10-100 Rule

The 1-10-100 rule states that as a product or service moves through the production system, the cost of correcting an error multiplies by 10.

Activity	Cost
Order entered correctly	$ 1
Error detected in billing	$ 10
Error detected by customer	$ 100

Dissatisfied customer shares the experience with others…

The difficulties with human error

Why existing tools are not enough

Motorola findings:

...it became evident early in the project that achieving a C_p greater than 2 would go only part of the way. Mistake-proofing the design would also be required ... Mistake-proofing the design is an essential factor in achieving the [total number of defects per unit] goal.

Smith, B. IEEE Spectrum 30(9) 43-47

Error proofing & SPC

- SPC is good at detecting shifts in the process mean or variance. Changes to the process must be ongoing to be readily detected.
- Human errors tend to be rare, intermittent events. They are not readily detected by control charts.
- Use error-proofing (not SPC) to reduce defects caused by human error

Motorola got an order of magnitude closer to their goal using a combination of SPC and error-proofing.

“Be more careful” not effective

- “The old way of dealing with human error was to scold people, retrain them, and tell them to be more careful … My view is that you can’t do much to change human nature, and people are going to make mistakes. If you can’t tolerate them ... you should remove the opportunities for error.”
- “Training and motivation work best when the physical part of the system is well-designed. If you train people to use poorly designed systems, they’ll be OK for awhile. Eventually, they’ll go back to what they’re used to or what’s easy, instead of what’s safe.”
- “You’re not going to become world class through just training, you have to improve the system so that the easy way to do a job is also the safe, right way. The potential for human error can be dramatically reduced.”

Chappell, L. 1996. The Pokayoke Solution. *Automotive News Insights,* (August 5): 24i.

LaBar, G. 1996. Can Ergonomics Cure ‘Human Error’? *Occupational Hazards* 58(4): 48-51.

What Causes Defects?

1. **Poor procedures or standards.**
2. **Machines.**
3. **Non-conforming material.**
4. **Worn tooling.**
5. ***Human Mistakes.***

Except for human mistakes these conditions can be predicted and corrective action can be implemented to eliminate the cause of defects

Inspection techniques

Poka yoke

Mistake-proofing systems

Does not rely on operators catching mistakes

Inexpensive Point of Origin inspection

Quick feedback 100% of the time

Seven Guidelines to Poka Yoke Attainment

1. Quality Processes - Design "Robust" quality processes to achieve zero defects.
2. Utilize a Team Environment - leverage the teams knowledge,experience to enhance the improvement efforts.
3. Elimination of Errors - Utilize a robust problem solving methodology to drive defects towards zero.
4. Eliminate the "Root Cause" of The Errors-Use the 5 Why's and 2 H's approach.
5. Do It Right The First Time - Utilizing resources to perform functions correctly the "first" time.
6. Eliminate Non-Value Added Decisions - Don't make excuses - just do it !
7. Implement an Incremental Continual Improvement Approach - implement improvement actions immediately and focus on incremental improvements; efforts do not have to result in a 100% improvement immediately.

Poka Yoke Systems Govern the Process

Two Poka Yoke System approaches are utilized in manufacturing which lead to successful zero defect systems:

1. Control Approach

Shuts down the process when an error occurs.

Keeps the "suspect" part in place when an operation is incomplete.

2. Warning Approach

Signals the operator to stop the process and correct the problem.

Common Mistake proofing Devices

- Guide Pins
- Blinking lights and alarms
- Limit switches
- Proximity switches
- Counters
- Checklists

Methods for Using Poka yoke

Poka yoke systems consist of three primary methods:

1. Contact
2. Counting
3. Motion-Sequence

Each method can be used in a control system or a warning system.

Each method uses a different process prevention approach for dealing with irregularities.

Contact Methods

Do not have to be high tech!

Passive devices are sometimes the best method. These can be as simple as guide pins or blocks that do not allow parts to be seated in the wrong position prior to processing.

Take advantage of parts designed with an uneven shape!

A work piece with a hole a bump or an uneven end is a perfect candidate for a passive jig. This method signals to the operator right away that the part is not in proper position.

Counting Method

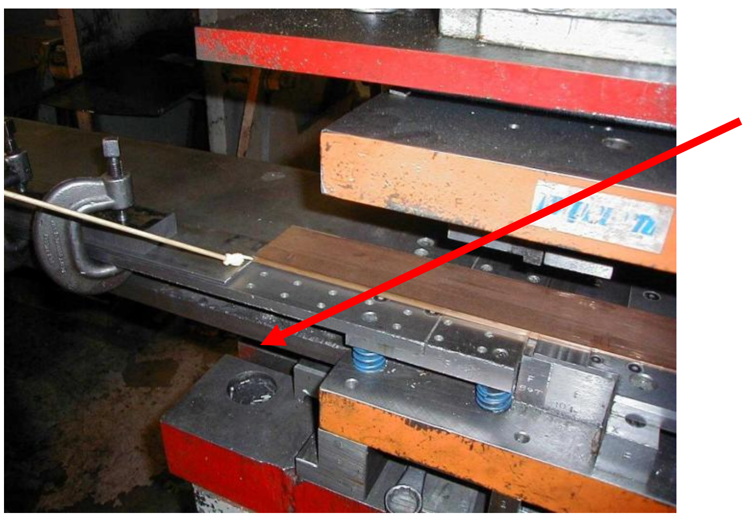
Used when a ***fixed*** number of operations are required within a process, or when a product has a fixed number of parts that are attached to it.

A sensor counts the number of times a part is used or a process is completed and releases the part only when the right count is reached.

Motion-Sequence Method

The third poka yoke method uses sensors to determine if a motion or a step in a process has occurred. If the step has not occurred or has occurred out of sequence, the the sensor signals a timer or other device to stop the machine and signal the operator.

This method uses sensors and photo-electric devices connected to a timer. If movement does not occur when required, the switch signals to stop the process or warn the operator.



Types of Sensing Devices

Sensing devices that are traditionally used in poka yoke systems can be divided into three categories:

1. Physical contact devices
2. Energy sensing devices
3. Warning Sensors

Each category of sensors includes a broad range of devices that can be used depending on the process.

3 Rules of POKA YOKE

- **Don't wait for the perfect POKA YOKE. Do it now!**
- **If your POKA YOKE idea has better than 50% chance to succeed…Do it!**
- **Do it now….improve later!**

Quick Changeover
Single Minute Exchange of Dies

Outline

- Changeover and Changeover Time
- Traditional Setup
- SMED
- SMED Process Steps
- Ideas for Improvement

Changeover Defined

- Changeover is the total process of converting a machine or line from running one product to another

Changeover Time Defined

- Changeover time is the total elapsed time between the last unit of good production of the previous run, at normal line efficiency, to the first unit of good production of the succeeding run, at full line efficiency.

Traditional approach

- Setup is given and fixed
- Therefore,
  - Use highly skilled setup personnel
  - Minimize product variety
  - Combine lots
  - Make large batches

Another way

- Setups CAN be improved!
- Small lot production REQUIRES short setups
- Setup time reduction of 90% and more is common

Benefits of setup reduction

- Better quality
- Lower cost
  - Less inventory
- Better flexibility
- Better worker utilization
- Shorter lead time and more capacity
- Less process variability

Classification of setup activities

- Type 1
  - Gathering, preparing, and returning tools, fixtures, etc.
- Type 2
  - Removing previous setup, mounting next setup on machine
- Type 3
  - Measuring, calibrating, adjusting
- Type 4
  - Producing test pieces, further adjustment until parts are good

What is SMED?

- Single Minute Exchange of Dies is changing process tooling in 9 minutes or less.
- The process was developed by Shigeo Shingo at Mazda, Mitsubishi and Toyota in the 1950's and 1960's.
  - Separate internal and external activities.
  - Convert internal activities to external activities.
  - Streamline all activities.

Single Minute Exchange of Dies

- Internal set-up activities.

  Elements in the changeover which can only be done when the machine is stopped.

- External set-up activities.

  Elements that can be performed when the machine is running.

Why SMED?

- Reduced inventories.
- Improved productivity.
- Higher quality levels.
- Increased safety.
- Improved flexibility.
- Reduction in throughput time.
- Improve operator capabilities.
- Lower manufacturing costs.

SMED Methodology

- Identify internal and external steps
- Convert internal steps to external
- Improve all aspects of the setup operation
- Abolish setup

The SMED Process

- Preliminary Stage – Observe and record.
- Stage 1 – Separate internal and external activities.
- Stage 2 – Convert internal activities to external activities.
- Stage 3 – Streamline all activities.
- Stage 4 – Document internal and external procedures.

Preliminary Stage

<u>Observe and record</u>

- Team-work
  - Recorder
    - Overall duration (from last product to first good product).
    - Describe the change (from what to what?).
    - Record the equipment used.
  - Timers
    - Time each step
  - Fact collectors
    - Breakdown the steps into actions – as much detail as possible.

Stage 1

Separate internal and external activities.

- Study each internal step and ask if it could be external.
- Common issues:
  - Dies in remote storage racks.
  - Spanners not available.
  - Raw material checks.
  - Lifting equipment not available.

Stage 2

<u>Convert internal to external.</u>

- Ask why the remaining internal steps can't be external.
- Re-examine the true function of each step.
- Common issues:
  - Cold dies – using material to heat the dies.
  - Imaginary center lines and reference planes.
  - No record of settings.

Stage 3

Streamline all activities.

- Analyze the elements (facts), and discuss all possible ways of improving the step.
- Study the external activities as well as the internal activities.
- Common issues:
  - Fastenings – Are bolts needed? If so remember that only the last turn tightens a nut or bolt.
  - Standardize bolt heads.
  - Standardize die heights.

Stage 4

<u>Document the procedures.</u>

- Write down the new internal and external procedures.
- Fill in an action sheet to ensure that the new procedures can be achieved.
- Review the whole activity to determine "What went well?", "What went badly?" and three changes that the team would make before the next SMED activity.

The SMED System - Results

Company	Machine	Before improvement	After improvement	Red'n
T Manufacturing[1]	80t single shot press	4 hours 0 mins	4 mins 18 sec	98%
S Metals[1]	100t single shot press	40 mins	2 mins 26 sec	94%
H Press[1]	30t single shot press	50 mins	48 sec	98%
TT Industries[1]	50 oz injection moulding m/c	1 hour 10 mins	7 mins 36 sec	89%
Expanded Metal Co.	4'6" lath press	4 hours 30 mins	11 mins (note: NOT SMED)	96%
S Engineering	Machining Centre	139 minutes	59 mins 29 secs	57% *
AM Bottlers	Bottling plant	32 mins 43 secs	23 mins 33 secs	28% *
E Finishing	Paint Plant	56 mins 26 secs	23 mins 12 secs	59% *

* After one SMED exercise

Ref 1: Modern Approaches to manufacturing improvement – the Shingo System, Shigeo Shingo, ISBN: 091529964x

Six Sigma

Outline

- What is Six Sigma?
- Phases of Six Sigma
  - Define
  - Measure
  - Evaluate / Analyze
  - Improve
  - Control
- Design for Six Sigma
- Green Belts & Black Belts

What is Six Sigma?

- A Vision and Philosophical commitment to our consumers to offer the highest quality, lowest cost products
- A Metric that demonstrates quality levels at 99.9997% performance for products and processs
- A Benchmark of our product and process capability for comparison to ‘best in class’
- A practical application of statistical Tools and Methods to help us measure, analyze, improve, and control our process

Why Companies Need Six Sigma

1. Reduces dependency on "Tribal Knowledge"
   - Decisions based on facts and data rather than opinion

2. Attacks the high-hanging fruit (the hard stuff)
   - Eliminates chronic problems (common cause variation)
   - Improves customer satisfaction

3. Provides a disciplined approach to problem solving
   - Changes the company culture

4. Creates a competitive advantage (or disadvantage)

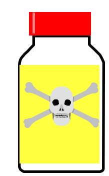
5. Improves profits!

How good is good enough?

<u>99.9% is already VERY GOOD</u>

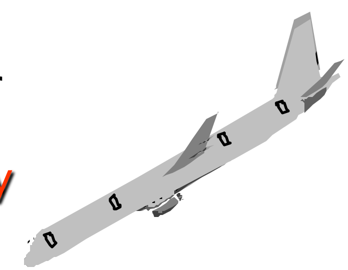
But what could happen at a quality level of 99.9% (i.e., 1000 ppm),

in our everyday lives (about 4.6σ)?

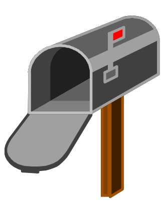


- 4000 wrong medical prescriptions each year

- More than 3000 newborns accidentally falling from the hands of nurses or doctors each year



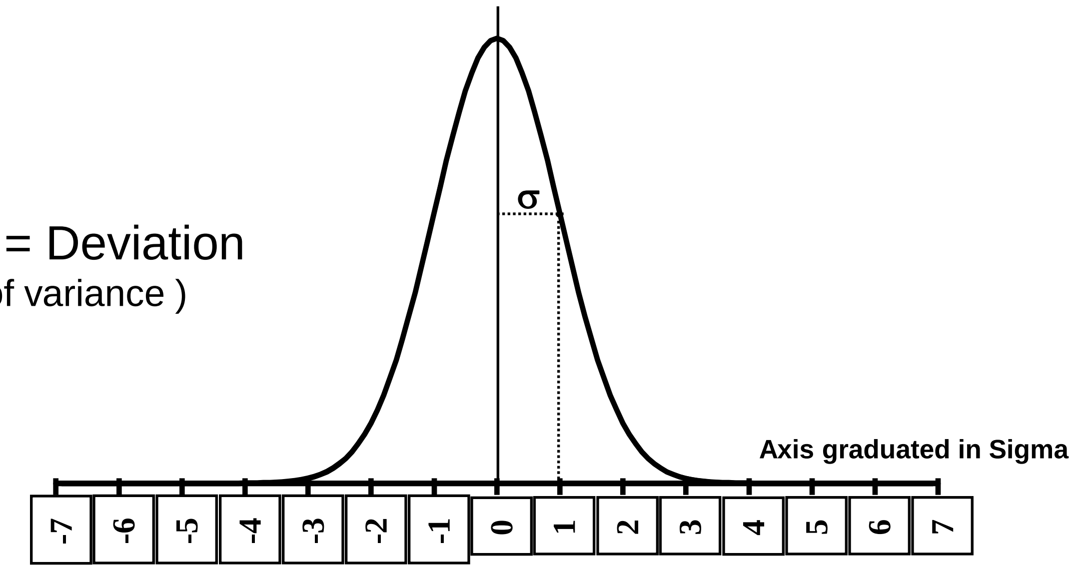
- Two long or short landings at American airports each day



- 400 letters per hour which never arrive at their destination

Six Sigma as a Metric

Sigma = σ = Deviation
(Square root of variance)



between + / - 1σ	68.27 %	result: 317300 ppm outside (deviation)
between + / - 2σ	95.45 %	45500 ppm
between + / - 3σ	99.73 %	2700 ppm
between + / - 4σ	99.9937 %	63 ppm
between + / - 5σ	99.999943 %	0.57 ppm
between + / - 6σ	99.9999998 %	0.002 ppm

3 Sigma Vs. 6 Sigma

The 3 sigma Company	The 6 sigma Company
▪ Spends 15~25% of sales dollars on cost of failure	▪ Spends 5% of sales dollars on cost of failure
▪ Relies on inspection to find defects	▪ Relies on capable process that don't produce defects
▪ Does not have a disciplined approach to gather and analyze data	▪ Use Measure, Analyze, Improve, Control and Measure, Analyze, Design
▪ Benchmarks themselves against their competition	▪ Benchmarks themselves against the best in the world
▪ Believes 99% is good enough	▪ Believes 99% is unacceptable
▪ Define CTQs internally	▪ Defines CTQs externally

Six Sigma ROI

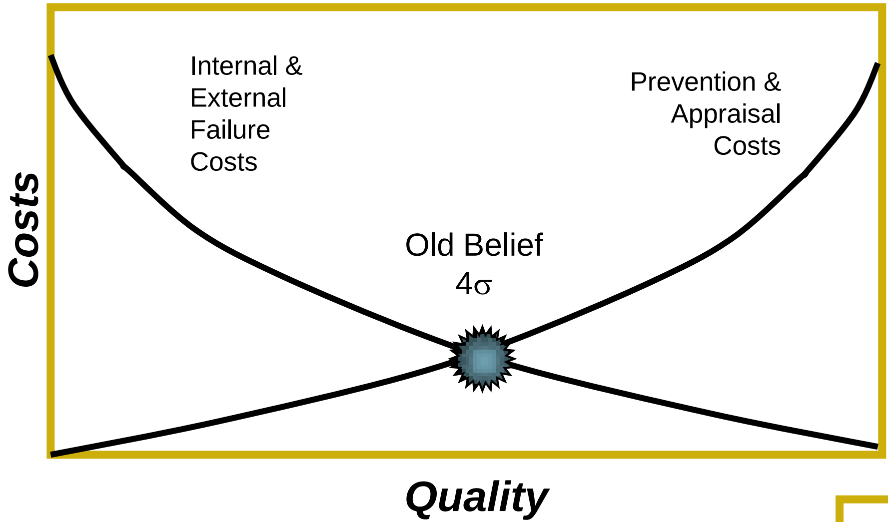
Motorola ROI
1987-1994

- Reduced in-process defect levels by a factor of 200.
- Reduced manufacturing costs by $1.4 billion.
- Increased employee production on a dollar basis by 126%.
- Increased stockholders share value fourfold.

AlliedSignal ROI
1992-1996

- $1.4 Billion cost reduction.
- 14% growth per quarter.
- 520% price/share growth.
- Reduced new product introduction time by 16%.
- 24% bill/cycle reduction.

Six Sigma as a Philosophy



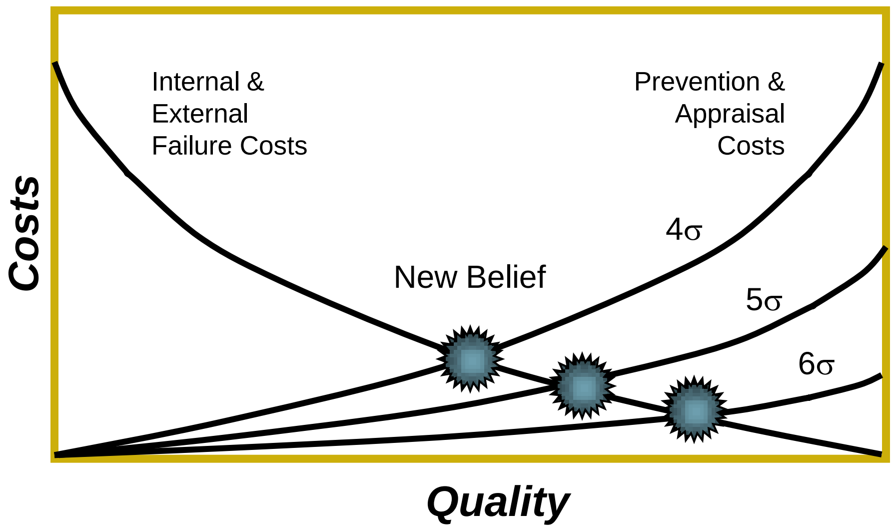
σ is a measure of how much variation exists in a process

Old Belief

High Quality = High Cost

New Belief

High Quality = Low Cost



Six Sigma Tools

Process Mapping

Structure Tree

Pareto Analysis

Gauge R & R

Rational Subgrouping

Baselining

Tolerance Analysis

Components Search

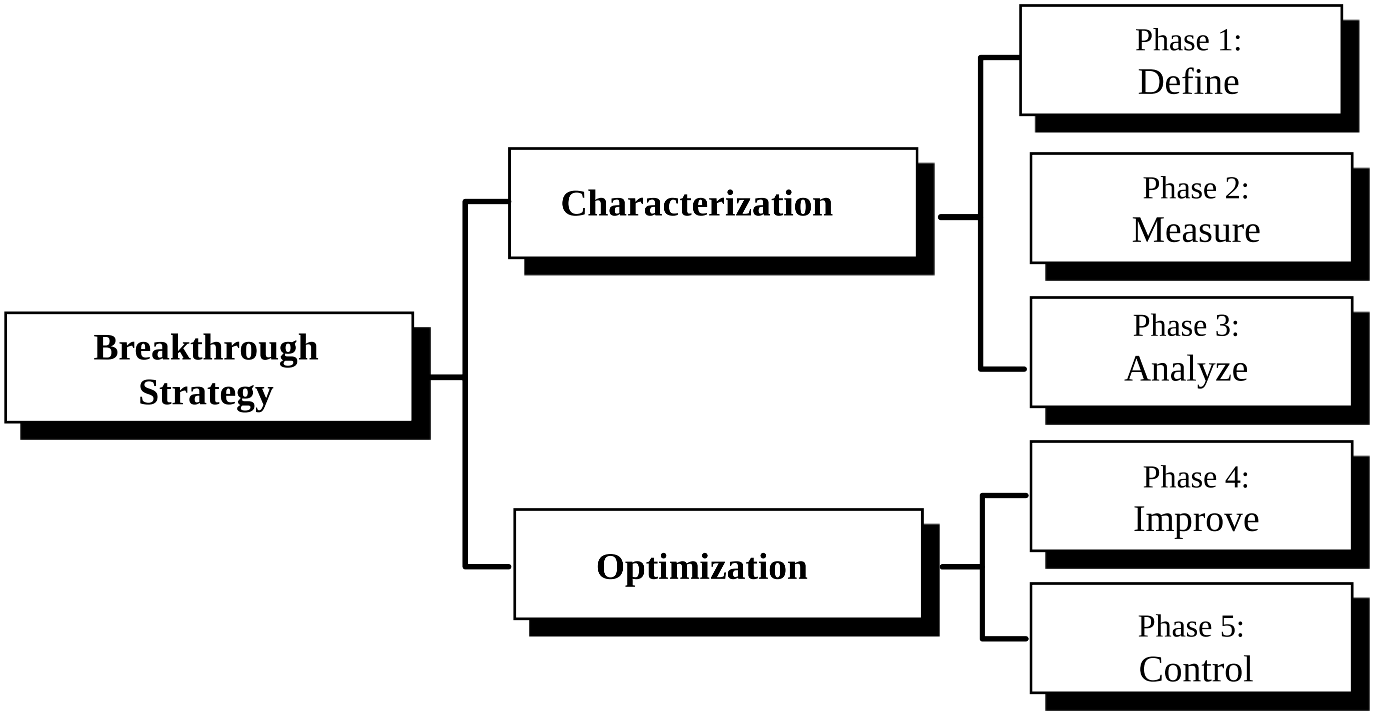
Hypothesis Testing

Regression

DOE

SPC

Problem Solving Methodology



Projects are worked through these 5 main phases of the Six Sigma methodology.

Define Phase

- Define Process
- Define Customer requirement
- Prioritize Customer requirement

Define Phase

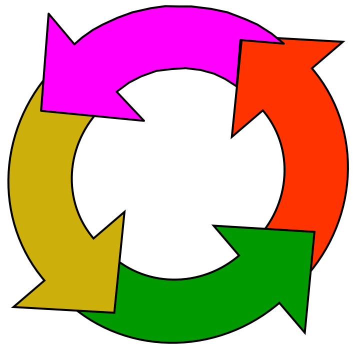
- SIPOC Model Kano Analysis
- Customer Survey CTQ Diagram
- Customer Requirement Analysis
- QFD Literature Review
- Standard / Regulation Review

Measure

Characterize Process

Evaluate

Understand Process



Control

Maintain New Process

Improve

Improve and Verify Process

Measure Phase

Define Problem

- Defect Statement
- Project Goals

Understand Process

- Define Process-Process Mapping
- Historical Performance
- Brainstorm Potential Defect Causes

Collect Data

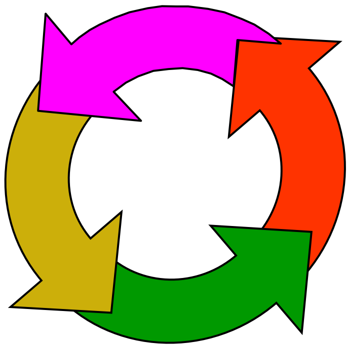
- Data Types
  - Defectives
  - Defects
  - Continuous
- Measurement Systems Evaluation (MSE)

Process Performance

- Process Capability
  - Cp/Cpk
  - Run Charts
- Understand Problem (Control or Capability)

Measure

Characterize Process



Evaluate
Understand Process

Control
Maintain New Process

Improve
Improve and Verify Process

Evaluate / Analysis Phase

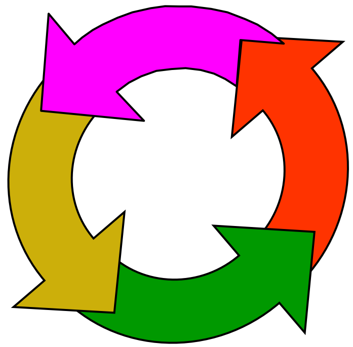
- Data Analysis
- Process Analysis
- Formulate Hypothesis
- Test Hypothesis

Measure

Characterize Process

Evaluate

Understand Process



Control

Maintain New Process

Improve

Improve and Verify Process

Improvement Phase

- Generate Improvement alternatives
- Validate Improvement
- Create “should be” process map
- Update FMEA
- Perform Cost/Benefit analysis

Design of Experiments (DOE)

- To estimate the effects of independent Variables on Responses.

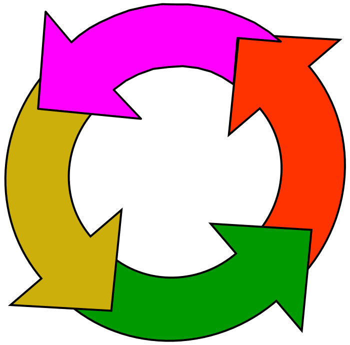
- Terminology
  - Factor – An independent variable
  - Level – A value for the factor.
  - Response - Outcome

Measure

Characterize Process

Evaluate

Understand Process



Control

Maintain New Process

Improve

Improve and Verify Process

Control Phase

Control Phase Activities:

- Confirmation of Improvement
- Confirmation you solved the practical problem
- Benefit validation
- Buy into the Control plan
- Quality plan implementation
- Procedural changes
- System changes
- Statistical process control implementation
- “Mistake-proofing” the process
- Closure documentation
- Audit process
- Scoping next project

Control Phase

Control Plan Tools:

1. Basic Six Sigma control methods.
   - 7M Tools: Affinity diagram, tree diagram, process decision program charts, matrix diagrams, interrelationship diagrams, prioritization matrices, activity network diagram.

2. Statistical Process Control (SPC)
   - Used with various types of distributions
   - Control Charts
     - •Attribute based (np, p, c, u). Variable based (X-R, X)
     - •Additional Variable based tools
       - -PRE-Control
       - -Common Cause Chart (Exponentially Balanced Moving Average (EWMA))

What is Design for Six Sigma (DFSS)?

DFSS Methodology & Tools

DESIGN FOR SIX SIGMA

Define	Measure	Analyze	Design	Verify
Initiate, scope, and plan the project	Under-stand customer needs and specify CTQs	Develop design concepts and high-level design	Develop detailed design and control/test plan	Test design and implement full-scale processes

DELIVERABLES

Define	Measure	Analyze	Design	Verify
Team Charter	CTQs	High-level Design	Detailed Design	Pilot

TOOLS

- Mgmt Leadership
- Project Management
- Customer Research
- QFD
- Benchmarking
- FMEA/Errorproofing
- Process Simulation
- Design Scorecards

Green Belts & Black Belts

- GE has very successfully instituted this program
  - 4,000 trained Black Belts by YE 1997
  - 10,000 trained Black Belts by YE 2000
  - "You haven't much future at GE unless they are selected to become Black Belts" - Jack Welch
- Kodak has instituted this program
  - CEO and COO driven process
  - Training includes both written and oral exams
  - Minimum requirements: a college education, basic statistics, presentation skills, computer skills
- Other companies include:
  - Allied Signal -Texas Instruments
  - IBM - ABB
  - Navistar - Citibank

Green Belts & Black Belts

	Task	Time on Consulting/ Training	Mentoring	Related Projects
Green Belt	Utilize Statistical/Quality technique	2%~5%	Find one new green belt	2 / year
Black Belt	Lead use of technique and communicate new ones	5%~10%	Two green belts	4 / year
Master Black Belt	Consulting/Mentoring/Training	80~100%	Five Black Belts	10 / year

Activity Based Costing and Lean Accounting

Outline

- What is Activity Based Costing?
- Cost Accounting Systems
- Traditional Cost Systems
- Activity Based Costing
- Implementing ABC
- Benefits & Limitations of ABC
- Lean Accounting

What is Cost Accounting?

- Cost Accounting involves the measuring, recording, and reporting of product costs
- Both the total cost and the unit cost of products are determined

Traditional Cost Systems

- Although it may be impossible to determine the exact cost of a product or service, every effort is made to provide the best possible cost estimate
- The most difficult part of computing accurate unit costs is determining the proper amount of overhead cost to assign to each product, service, or job

Overhead Costs

- A single predetermined overhead rate is used throughout the year for the entire factory operation for the assignment of overhead costs
- In job order costing, direct labor hours or costs are commonly used as the relevant activity base
- In process costing, machine hours are commonly used as the relevant activity base

Activity-Based Costing

- Allocates overhead to multiple activity cost pools and assigns the activity cost pools to products by means of cost drivers
- An activity is any event, action, transaction, or work sequence that causes the incurrence of cost in producing a product or providing a service
- A cost driver is any factor or activity that has a direct cause-effect relationship with the resources consumed

Activity-Based Costing

- Allocates costs to activities first, and then to the products, based on the product's use of those activities
- Activities consume resources
- Products consume activities

Activity-Based Costing

- Not all products or services share equally in activities.
- The more complex a product's manufacturing operation, the more activities and cost drivers it is likely to have.

Unit Costs under ABC

Activity-based costing involves the following steps:

1. Identify the major activities that pertain to the manufacture of specific products and allocate manufacturing overhead costs to activity cost pools.
2. Identify the cost drivers that accurately measure each activity's contributions to the finished product and compute the activity-based overhead rate.
3. Assign manufacturing overhead costs for each activity cost pool to products using the activity-based overhead rates (cost per driver).

Benefits of Activity-Based Costing

- ABC leads to more activity cost pools with more relevant cost drivers
- ABC leads to enhanced control of overhead costs since overhead costs can be more often traced directly to activities
- ABC leads to better management decisions by providing more accurate product costs, which contributes to setting selling prices that will achieve desired product profitability levels

Benefits of ABC

- **ABC leads to better management decisions**. More accurate product costing helps in setting selling prices and in deciding to whether make or buy components.
- Activity-based costing does not, in and of itself, change the amount of overhead costs.

Limitations of ABC

- ABC can be expensive to use, as a result of the higher cost of identifying multiple activities and applying numerous cost drivers
- Some arbitrary overhead costs will continue, even though more overhead costs can be assigned directly to products through multiple activity cost pools

When to Use ABC

- Product lines differ greatly in volume and manufacturing complexity
- Product lines are numerous, diverse, and require differing degrees of support services
- Overhead costs constitute a significant portion of total costs
- The manufacturing process or the number of products has changed significantly
- Production or marketing managers are ignoring data provided by traditional cost systems and are using bootleg cost information to make pricing decisions

Activity-Based Management

- ABM is an extension of ABC, from a product costing system to a management function, that focuses on reducing costs and improving processes and decision making

Lean Accounting

- Lean Accounting is intended to replace traditional accounting and measurement systems; it is **not** intended be an additional analysis. Lean Accounting is right for companies that are well on the path toward lean manufacturing.
- Lean Accounting is more than a set of tools relating to measurement, capacity usage, value, and continuous improvement. Together these tools become a lean business management system that is radically different from traditional management.

Lean Accounting – The Lean Transition

- An important role for finance and accounting people in the lean organization is to actively support and participate in the transition to a lean enterprise.

Lean Accounting – Management Accounting

- A cornerstone of the lean business is performance measurement. We have few measurements that are focused on the creation of customer value and the achievement of business strategy.
- Measurements are primarily non-financial and are established for cells, value streams, plants, and corporations. Simplified costing and financial planning methods support these measurements.

Lean Accounting – Business Management

- To manage the business we need timely and valid information. Decisions are made using lean principles, not the traditional mass production mentality.
- Replace the department-focused structure with an organization that is focused on customer value and the value streams. Drive the business from value to the customer.

Lean Accounting – Operational Accounting

- The problems of standard costing need to be addressed. Standard costing is an excellent costing method for traditional mass production; but standard costing is actively harmful to lean organizations.
- Replace standard costing with value stream costing. Value stream costing eliminates most transactions and does not rely on allocation and full absorption of costs.

Lean Accounting – Financial Accounting

- While the majority of Lean Accounting affects internal processes, Lean principles are applied equally to the company's financial accounting. There is much waste to be eliminated.
- Finance and accounting people in the average American company spend more than 70% of their time on bookkeeping and very little time on analysis and improvement.

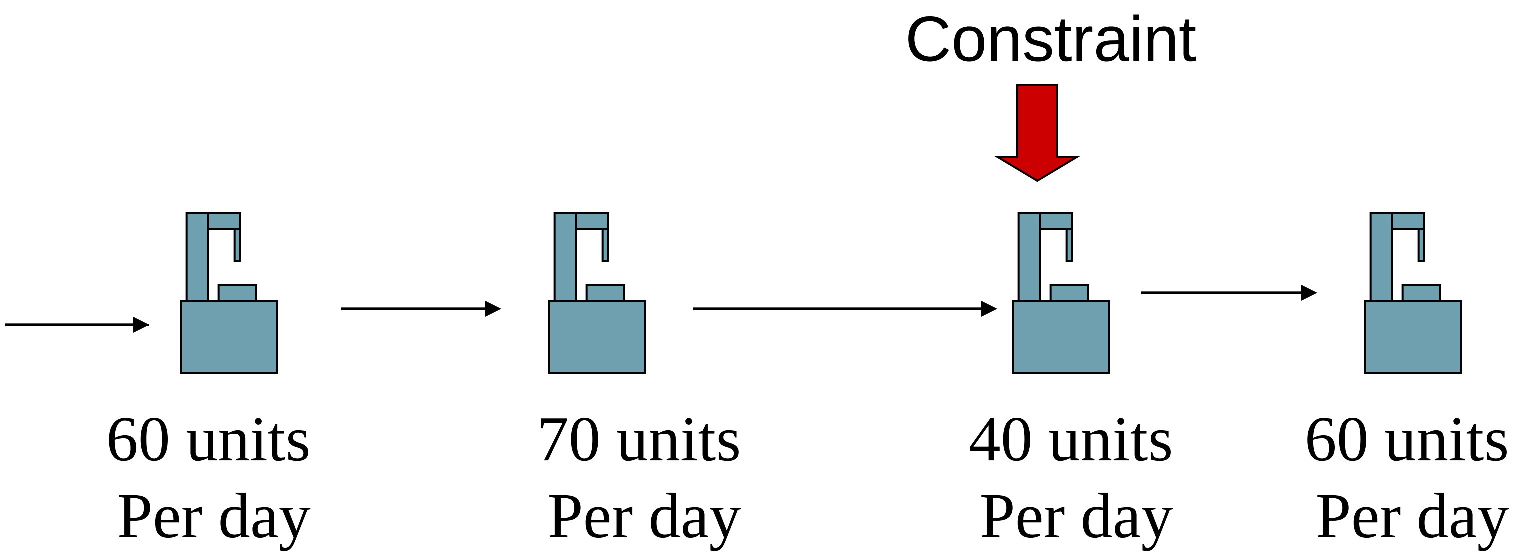
Theory of Constraints

Outline

1. Introduction to Constraints
2. Five Steps Of Theory of Constraints
3. Drum Buffer Rope
4. Issues with TOC
5. Measurements

Constraints

Any system can produce only as much as its critically constrained resource



Maximum Throughput = 40 units per day

Significance of Bottlenecks

- Maximum speed of the process is the speed of the slowest operation
- Any improvements will be wasted unless the bottleneck is relieved

Theory of Constraints

- Purpose is to identify constraints and exploit them to the extent possible
  - Identification of constraints allows management to take action to alleviate the constraint in the future

Theory of Constraints

- Assumes current constraints cannot be changed in the short-run
  - What should be produced now, with current resources, to maximize profits?
    - Question cannot be answered by traditional accounting methods

Theory of Constraints

- Based on the concepts of drum, buffer and ropes
  - Drum
    - Output of the constraint is the drumbeat
      - Sets the tempo for other operations
      - Tells upstream operations what to produce
      - Tells downstream operations what to expect

Theory of Constraints

- Buffer
  - Stockpile of work in process in front of constraint
    - Precaution to keep constraint running if upstream operations are interrupted
- Ropes
  - Limitations placed on production in upstream operations
    - Necessary to prevent flooding the constraint

What is the Theory of Constraints?

"The core idea in the Theory of Constrains is that every real system such as a profit-making enterprise must have at least one constraint".

What is TOC? (continued)

"There really is no choice in the matter.   Either you manage constrains or they manage you. The constraints will determine the output of the system whether they are acknowledged and managed or not"

Noreen, Smith, and Mackey,   The Theory of Constraints and its Implecations for Management Accounting (North River Press, 1995)

How does TOC help companies?

1. Focusing improvement efforts where they will have the greatest immediate impact on the bottom line.

2. Providing a reliable process that insures Follow Through!

Five Steps Of TOC

1. Identifying the constraint

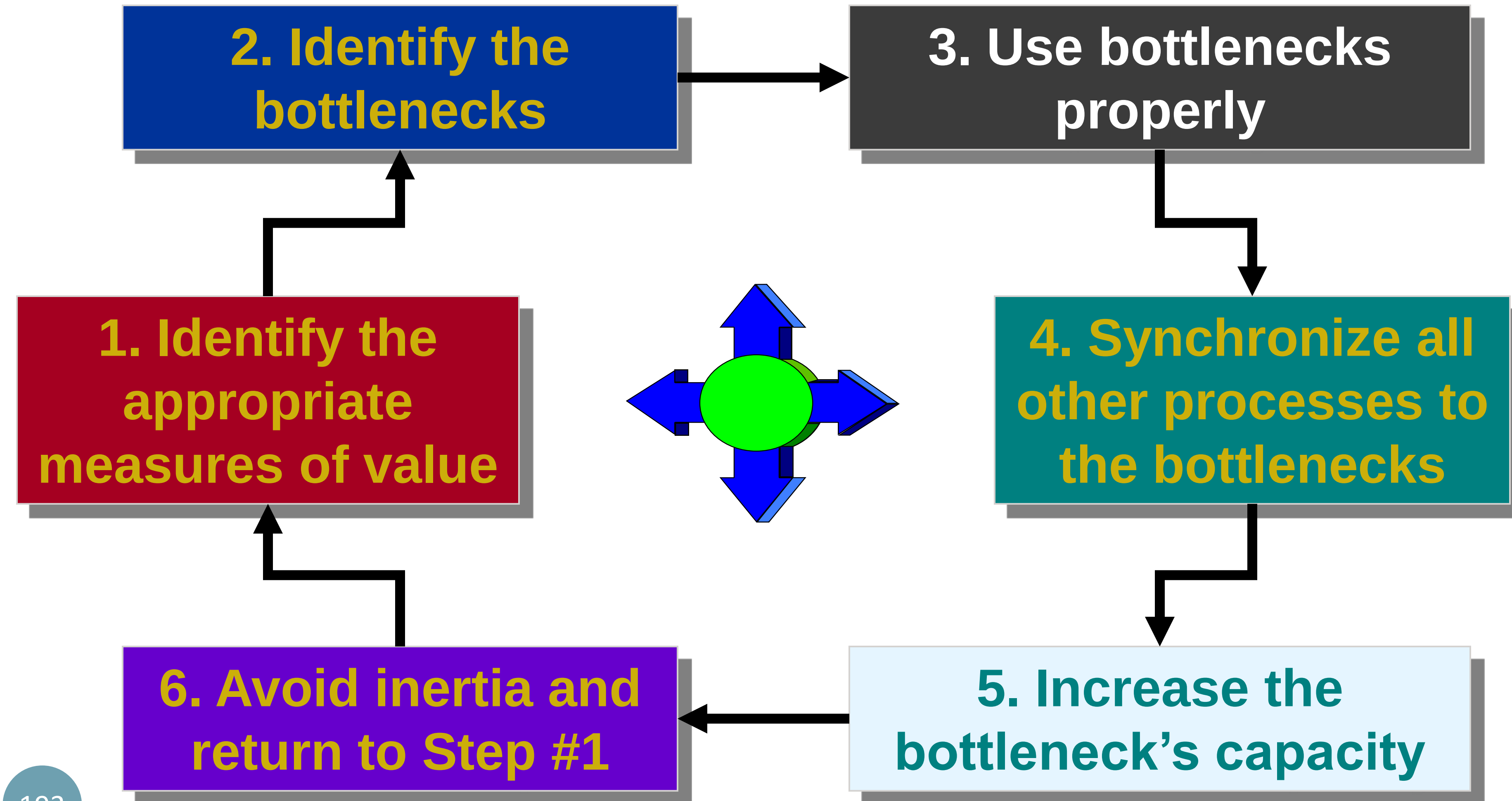
2. Decide how to exploit the constraint

3. Subordinate everything else to the decision in step 2

4. Elevate the constraint

5. Go back to step 1, but avoid inertia

Theory of Constraints



Steps in the TOC Process

- Identify the system constraints

- Internal
  - Process constraints
    - Machine time, etc.
  - Policy constraints
    - No overtime, etc.

- External
  - Material constraints
    - Insufficient materials
  - Market constraints
    - Insufficient demand

Steps in the TOC Process

- Decide how to exploit the constraint
  - Want it working at 100%
  - How much of a buffer?

Steps in the TOC Process

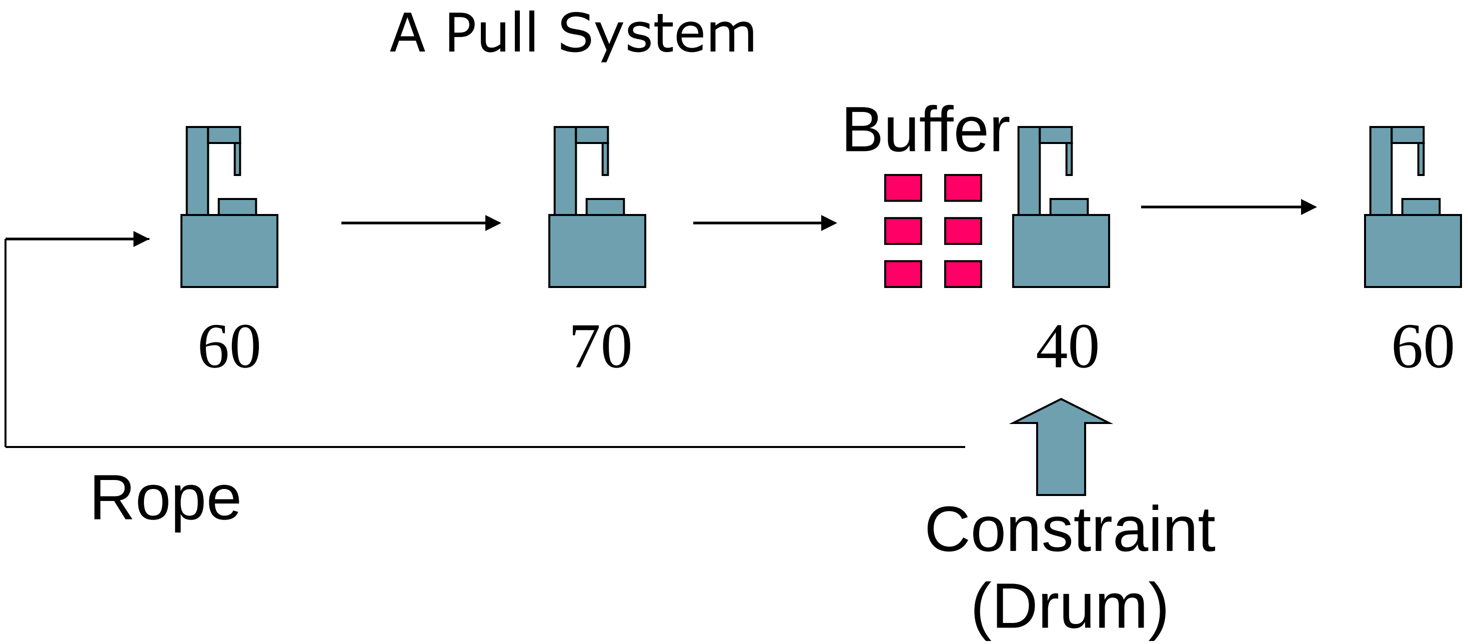
- Subordinate everything else to the preceding decision
  - Plan production to keep constraint working at 100%
  - May need to change performance measures to “rope” upstream activities

Steps in the TOC Process

- Elevate the constraint
  - Determine how to increase its capacity
- Repeat the process
  - Always a new constraint

Drum Buffer Rope

- Drum-Buffer-Rope for Shop Floor Control
  - **Drum**: The Pace Setting Resource - constraint
  - **Buffer**: The amount of protection in front of the resource
  - **Rope**:The scheduled staggered release of material to be in line with the Drum's schedule.



Lean: How DBR Supports it

Fundamentally, Don't Build Until Needed

- Overproduction avoided because DBR is "pull" system
- Inventory minimized because only buffer at constraint
- Transportation reduced because "unbuilt material" doesn't move
- Processing waste minimized because "unbuilt material"
- Unnecessary Motion decreased because don't build unneeded
- Waiting is eliminated at the constraint –only place that counts
- Defects avoided because of "small lot", non conformance, and corrective action

Issues with TOC

- Upstream operations must provide only what the constraint can handle
- Downstream operations will only receive what the constraint can put out
- Constraint must be kept operating at its full capacity
  - If not, the entire process slows further

Issues with TOC

- Advantages
  - Improves capacity decisions in the short-run
  - Avoids build up of inventory
  - Aids in process understanding
  - Avoids local optimization
  - Improves communication between departments

Issues with TOC

- Disadvantages
  - Negative impact on non-constrained areas
    - Diverts attention from other areas that may be the next constraint
    - Temptation to reduce capacity

Issues with TOC

- Ignores long-run considerations
  - Introduction of new products
  - Continuous improvement in non-constrained areas
- May lead organization away from strategy
- Not a substitute for other accounting methods

Measurements

Conventional Wisdom

- Net profit?
- Efficiency?
- Utilization?
- Return on Investment?
- Cash Flow?

"Are you using the right measurements?"

Jonah in The Goal

Measurements

TOC Wisdom

- Throughput
- Inventory
- Operating Expense

Traditional vs JIT, TQM and TOC

Traditional Ranking

- Operating expense
- Throughput
- Inventory or Assets

JIT, TQM and TOC

- Throughput
- Inventory or Assets
- Operating expense

All Three methods attack the underlying assumption that crated a problem related to inventory levels. They ask:

WHY DO WE NEED INVENTORY TO PROTECT THROUGHPUT ?

The “Cost World”

- Decreasing “OE” is definitely #1 because we have relatively high control of our expenses.
- Increasing “T” is always important, but it ranks #2 because we are at the mercy of the marketplace and have less control over sales.
- Inventory tends to fall into a “grey area” that we don’t know exactly what to do about; it is a “necessary evil” that must be lived with to protect sales.

The “Throughput World”

- Increasing “T” is unquestionably #1 because it has the greatest potential impact on the bottom line.
- Decreasing “I” is #2 because excess WIP and finished goods jeopardize future throughput.
- Decreasing “OE” is #3 because significant reductions (workforce reductions) usually jeopardize future throughput.

Financial Issues

- TOC is a management tool, not a financial tool
- Not used to determine inventory values
- Not used to allocate overhead to inventory
- Does not comply with GAAP
- Does indicate how to use available resources most effectively

Conclusion

- In the throughput world, constraints become the main tools of management and the previous tool, product cost, can be discarded.

Human Factors

Outline

1. Ergonomics
2. Knowledge Management
3. Rewards & Recognition
4. Safety & Health
5. Effective Teams
6. Conducting Effective Meetings

Ergonomics

WHAT IS ERGONOMICS?

- It is the practice of arranging the environment to fit the person working in it.

- Ergonomic principles help reduce the risk of potential injuries from :

  * Overuse of muscles
  * Bad Posture
  * Repetitive motion

- Objective of ergonomics is to accommodate workers through the design of:

  * Tasks
  * Controls
  * Tools
  * Work stations
  * Displays
  * Lighting & equipment

WHAT MAKES AN EFFECTIVE PROGRAM?

- Management commitment and employee involvement are essential.

- Management can provide:
  * Resources (Time, people, financial)
  * Managing & motivating forces behind effort

- Employees can provide:
  * Intimate knowledge of the jobs performed
  * Identification of existing & potential hazards

- Together they provide the solutions to the issues.

CAUSES & CONTRIBUTING FACTORS

SHORT TERM INJURIES/Acute exposures:

- Identifiable accident or trauma caused injury

LONG TERM INJURIES/Chronic exposures

- Problems builds over time, no specific accident source

UNSAFE CONDITIONS

- Weight of object
- Size & shape
- Height of work
- Housekeeping

UNSAFE ACTIONS

- Improper lifting/lowering
- Twisting with a load
- Excessive reaching
- Lifting beyond capacity

HAZARD PREVENTION & CONTROL

ENGINEERING CONTROLS

- Eliminate the task or unnecessary movement.
- Reduce weights of loads, increase handling capacity of equipment.
- Workspace modifications.
- Use handles or “easy grip” surfaces.
- Investigate quality problems that may cause stresses.
- Lift properly, keeping loads close to body.
- Logical, convenient controls and displays.

HAZARD PREVENTION & CONTROL CONTINUED

ADMINISTRATIVE & PROCESS CONTROLS

- Work rest or break scheduling.
- Training in proper lifting techniques & ergonomics.
- Job orientation, training and follow up.
- Rotation between high & low stress tasks.
- Housekeeping.
- Video study and evaluation of job tasks.
- Use of effective job safety analysis program.
- Enforcement of existing procedures.

ERGONOMIC MODIFICATION PROCESS

1) Identify existing or potential problems
   - Analyze injury data
   - Interview staff & employees
   - Observe work activity
   - Conduct initial ergonomic evaluation

2) Identify & evaluate risk factors involved.
3) Review data, info. with Management and employees.
4) Design & implement corrective measures.
5) Monitor & evaluate effectiveness of corrective measures.

WORK PRACTICE CONTROLS

The key elements of an effective work practice program are:

- Instruction in proper work techniques.
- Employee training & conditioning.
- Regular monitoring.
- Feedback.
- Adjustments.
- Modification.
- Maintenance.

WORK AT WORKING SAFELY

Awareness of ergonomics and the causes of related disorders
is critical in prevention efforts:

- Cooperate with employer in making related design changes in the workplace.
- Be aware of signs & symptoms indicating a possible problem or injury caused by poor workplace design.
- Participate in hazard controls initiated by employer.
- Be aware of job-specific techniques used to alleviate ergonomic issues.
- Follow doctor’s instructions, if under treatment.

Knowledge Management

Why Knowledge Management?

Knowledge is:

- The cutting edge of organizational success (Nonaka, 1991)
- The engine transforming global economies (Bell, 1973, 1978)
- Leading us toward a new type of work with new types of workers (Blackler, Reed and Whitaker, 1993)
- The element that will lead to the demise of private enterprise capitalism (Heilbruner, 1976)
- The sum total of value-added in an enterprise (Peters, 1993)
- The "mobile and heterogeneous [resource that will end the] hegemony of financial capital [and allow employees to] seize power" (Sveiby & Lloyd, 1987)

Knowledge results in:

- The "learning organization" (Mayo & Lank, 1995)
- The "brain-based organization" (Harari, 1994)
- Intellectual capital" (Stewart, 1994)
- "Learning partnerships" (Lorange, 1995)
- Obsolete capitalists economies and radically different societies (Drucker, 1993)

Conclusion

Knowledge is fast becoming a primary factor of production (e.g., Handy, 1989, 1994; Peter, 1993; Drucker, 1992)

Source: Theseus International Management Institute, February 2000

Barriers to Knowledge Management Success

Results From International Survey:

❖ Organizational Culture	80%
❖ Lack of Ownership	64%
❖ Info/Comms Technology	55%
❖ Non-Standardized Processes	53%
❖ Organizational Structure	54%
❖ Top Management Commitment	46%
❖ Rewards / Recognition	46%
❖ Individual vice Team Emphasis	45%
❖ Staff Turnover	30%

Earnst & Young KM International Survey, 1996
(431 senior executive responses)

Summary

- ❖ **Embodies a theory for knowledge management, with validated key elements as design inputs**
- ❖ **Enterprise-wide approach in the design of a knowledge management system**
- ❖ **Systems' perspective throughout the various phases of system design**
- ❖ **Integrates both integrative management and systems engineering disciplines into a single construct to ensure successful design, implementation, and management of a knowledge management system.**

If taking a true systems approach, a knowledge management system will enhance efficiency, effectiveness, and innovation through leveraging its enterprise's intellectual assets.

Rewards & Recognition

Rewards & Recognition

Seven steps for a rewards and recognition system

1. **Develop a rewards and recognition strategy.**
   - Starting with the organization's priorities and values, determine the behaviors you want to recognize (these are your strategic objectives) and the strategic initiatives you may need to take within each facet of your pride and recognition program.

Rewards & Recognition

Seven steps for a rewards and recognition system

2. Review your formal awards.

- You may need to make adjustments to the awards programs you already have to ensure they support your strategic objectives.

Rewards & Recognition

Seven steps for a rewards and recognition system

3. Align your informal awards.

- Your informal awards also need to reinforce your overall directions and values. The key here is to customize your informal awards to fit your culture and employees.

Rewards & Recognition

Seven steps for a rewards and recognition system

4. **Determine the reinforcing day-to-day managerial behaviors.**
   - What we are looking at here is 'walking the talk'. The management team at all levels needs to be aware of how their day-to-day decisions and actions affect employees' behavior. Organizational health surveys and other feedback mechanisms may assist managers in gaining this understanding and in making adjustments where required.

Rewards & Recognition

Seven steps for a rewards and recognition system

5. Align other management systems.

- Consider whether other systems such as performance management, training, resource allocation and staffing support your pride and recognition strategy and program.

Rewards & Recognition

Seven steps for a rewards and recognition system

6. Establish a feedback system.

- An on-going approach to monitoring and improving the program will ensure it continues to promote the changing culture and directions of your organization. You might consider integrating reward and recognition indicators with financial and other performance measures.

Rewards & Recognition

Seven steps for a rewards and recognition system

7. Market the program.

- Bring attention to your activities, not only within your organization, but also to other departments and external agencies and associations.

Safety & Health

Cost of Accidents

- Direct Costs
  - Medical Costs (including worker's comp)
  - Indemnity Payments
- Indirect costs
  - Time Lost (by worker and supervisor)
  - Schedule delays
  - Training new employees
  - Cleanup time / equipment repairs
  - Legal fees

Legal Issues and Liability

- As a result of safety violations:
  - You can be named in a law suit
  - Criminal charges may be filed against you
  - You can be cited by an enforcement agency
  - You can be fined by an enforcement agency
  - Your lab/workplace can be shut down by an enforcement agency

Accident Causes

- Unsafe Conditions
  - Easiest to correct (and very cost effective)
  - Easiest to prevent
    - Safety audits
    - Safety inspections
    - Maintenance schedules for equipment
    - Encouraging employee reporting
    - Good housekeeping

Accident Causes

- Unsafe Acts
  - Most difficult to address
    - Changing behavior isn't easy
  - Best prevented by developing a "safety culture"

Establishing Accountability

- Charge back systems
- Safety goals
  - Accident costs
    - Equipment damage
    - Lost time
  - Accident rates
    - First aid #s
    - Workers comp #s
  - Loss ratios (including automobile rates)
- Safety Activities
  - Safety meetings, inspections, using PPE

Defining Responsibilities

- Employee responsibilities include:
  - Recognizing safety hazards
  - Reporting safety hazards
  - Maintaining good housekeeping
  - Working safely
  - Using personal protective equipment (PPE)
  - Making the most of safety training

Defining Responsibilities

- Employer responsibilities include:
  - Providing access to information
    - Haz Com - MSDSs, written program
    - Bloodborne Pathogens – written program
    - Lab Safety – chemical hygiene plan

Defining Responsibilities

- Employer responsibilities (cont.)
  - Providing training
    - Hazard Communications
      - Annual & within first 30 days of employment, also when new hazards are introduced
    - Quarterly safety training (required by state)
    - Special programs
      - Laboratory
      - Bloodborne pathogens
      - Respirators
      - Forklifts

Effective Teams

Your Organization Can Benefit from Teams

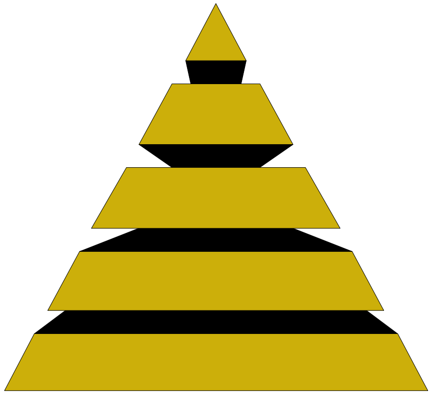
- Team output usually exceeds individual output.
- Complex problems can be solved more effectively.
- Creative ideas usually are stimulated in the presence of other individuals who have the same focus, passion, and excitement.
- Teams both appreciate and take advantage of diversity.
- Support arises among team members.

The Importance of Creating High Performance Teams

- Characteristics of High Performing Teams
  - Small Size
  - Complimentary Skills
  - Common Purpose
  - Specific Goals
  - Mutual Accountability

The Five Stages of Team Development

- Forming
- Storming
- Norming
- Performing
- Adjourning



Conducting Effective Meetings

Conducting Effective Meetings

- Preparing for the Meeting
  - Set Objectives – problems to solve, issues to address, decisions to be made
  - Select Participants
  - Set a Time and Place
  - Plan the Agenda
  - Distribute the Agenda and Relevant Materials in Advance
  - Consult with Participants Before the Meeting

Conducting Effective Meetings

- Conducting the Meeting
  - Begin the Meeting with the Agenda
  - Establish Specific Time Parameters
  - Control the Discussion
  - Use Problem Solving Techniques
  - Encourage and Support Participation by All Members

Conducting Effective Meetings

- Conducting the Meeting
  - Encourage the Clash of Ideas, but Discourage the Clash of Personalities
  - Exhibit Effective Listening Skills
  - Reach a Consensus
  - End the Meeting by Clarifying What Happens Next

Conducting Effective Meetings

- Follow Up after the Meeting
  - Spend the Last Five Minutes Debriefing the Meeting Process.
  - The Best Time to Share Your Reactions to the Meeting Is Right After It Has Ended
  - Brief Memo Summarizing

    Discussions, Decisions, and Commitments (minutes)

The End

(or really only the beginning…)

Visit www for more information