INTRODUCTION TO LEAN MANUFACTURING

Sam Lines, Concrete Sealants, Inc.

1

HISTORY

Is Lean Manufacturing a new concept?

NO!

The concept has been around since the invention of the wheel.

We have really seen the impact over the past 200 years.

2

ELI WHITNEY (1765-1825)

- Inventor of the Cotton Gin
- Credited for the promotion of interchangeable parts.
- One of the inventors of the milling machine

Design

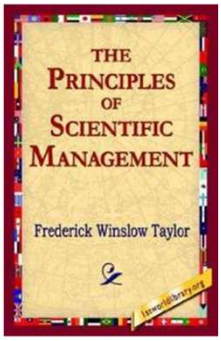
3

FREDRICK TAYLOR (1856-1915)

- "Father" of Scientific Management
- Sought industrial efficiency
- Time and motion study
- "One best way"
  - Emphasis on speed
- Division of labor
- "First class" worker concept

Speed

FIGURE 4.—STOP WATCH WITH DECIMAL FACE



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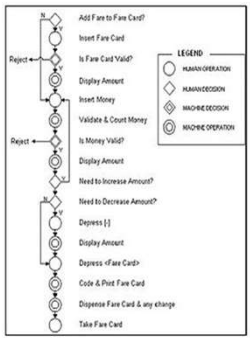
FRANK GILBRETH, SR. (1868-1924)

- Efficiency through reduced motion
- "Therblig"
  - The measure for the number of units for a process
- Process flow chart
- "One best way"
  - Emphasis on process
- His work was continued after his death by his wife, Lillian.

Process



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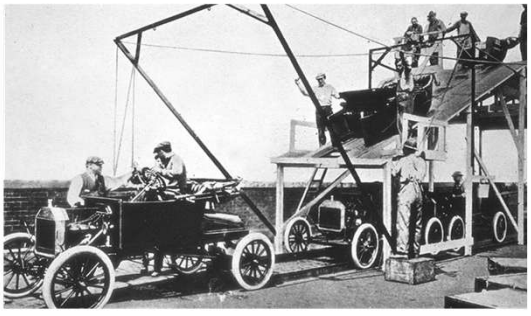
HENRY FORD (1863-1947)

- Assembly line
  - Mass production
  - Interchangeable parts
  - Division of labor
- "Fordism"
  - Standardization
  - Tooling
  - High employee wages ($5 / day)
  - Became the "Flexible System of Production"

Assembly



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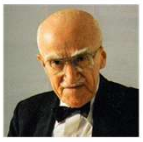
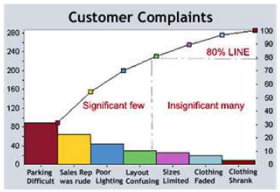
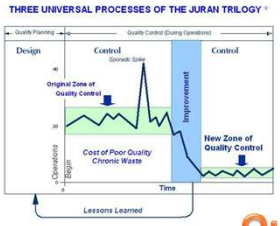
ERA OF QUALITY GURU'S

- W. Edwards Deming (1900-1993)
  - The Deming system of profound knowledge
  - Key Principles (14 Points)
  - Seven Deadly Diseases
  - Plan, do, check, act
- Joseph Juran (1904-2008)
  - Application of the Pareto Principle to quality
  - Brought quality circles to the US from Japan
  - Developed Juran's Trilogy







Quality

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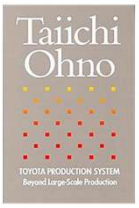
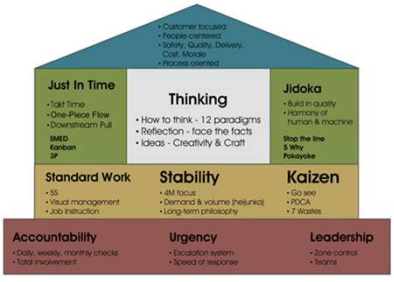
THE TOYOTA PRODUCTION SYSTEM

- Taiichi Ohno (1912-1990)
  - Father of the Toyota Production System
  - Created the seven wastes (muda)
  - Created the Just-In-Time (JIT) concept
- Shigeo Shingo (1909-1990)
  - Documented the Toyota Production System
  - Added "poke-yoke", or mistake proofing; and
  - Single minute exchange of dies (SMED)
  - Idea of "zero quality control"


Taiichi Ohno

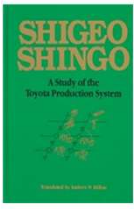


TPS



TOYOTA


Shigeo Shingo



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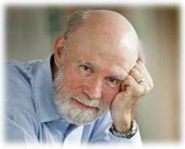
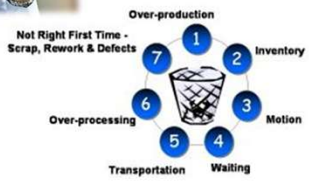
LEAN MANUFACTURING TODAY

- The term was first coined by John Krafcik in a Fall 1988 article, "Triumph of the Lean Production System," published in the Sloan Management Review.
- Authors Jim Womack, Daniel Jones, and Daniel Ross wrote the book *The Machine that Changed the World* in 1990
- The concept is to **Avoid and then Reduce Waste** in processes.



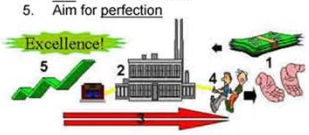
The 7 Wastes



TAKE A WALK!
to your Gemba

Lean Principes

1. Specify value for the customer
2. Integrate the Value Stream
3. Create Flow
4. Pull from the customer
5. Aim for perfection



Lean Manufacturing

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AND THE TWO SHALL BE ONE

Lean		Six Sigma	
▫ Removes Waste ▫ Increases Speed ▫ Removes non-value added process steps ▫ Fixes connections between process steps ▫ Focuses on the customer		▫ Reduces Variation ▫ Improves Quality ▫ Reduces variation at each remaining step ▫ Optimizes remaining process steps ▫ Focuses on the customer	
Speed	+	Accuracy	=

Better Delivery Better Quality Satisfied Employees Satisfied Customers

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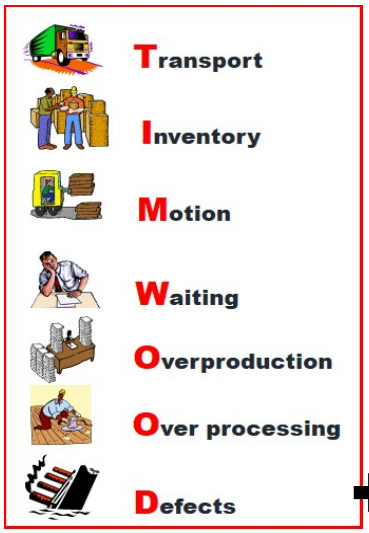
LET'S FIRST LOOK AT LEAN

- Seek out and eliminate waste



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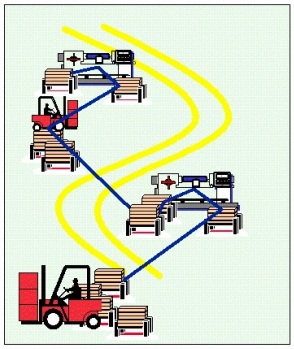
Transportation

Poor layout exacerbates transportation wastes



- Transport waste is material movement that is not directly associated with a value adding process
- Processes should be as close together as possible and material flow directly from process to process without any significant delays in between
- Excess transportation may be caused by :
  - Poor layouts
    - Large distance between operations
  - Lengthy, or complex material handling systems
  - Large batch sizes
  - Working to faster rate than customer demand (overproduction)
  - Multiple storage locations

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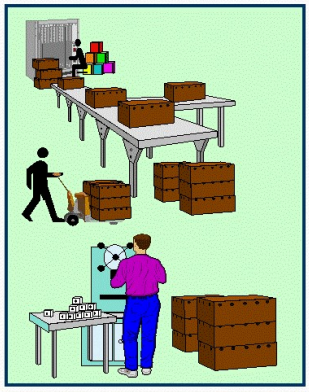
Inventory

Stock wastes space and effort



- Inventory waste is stock and work in process in excess of the requirements necessary to produce goods or services 'just in time'
- Unnecessary inventory that accumulates before or after a process is an indication that continuous flow is not being achieved
- Excess inventory be caused by
- Lack of balance in work flow, forcing inventory build-up between processes
- Large batch sizes
- Failure to observe first in first out - stagnant materials
- Incapable processes
- Long changeover time
- Not adhering to procedures

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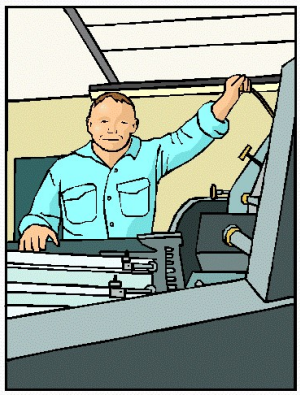
Motion

Work smarter not harder



- Waste of motion is any motion of man and / or Equipment that does not add value to the product or service
- Wasteful motion is caused by:
  - Poor workstation layout - excessive walking, bending reaching
  - Poor method design - transferring parts from one hand to another
  - Poor workplace organisation
  - Large batch sizes
  - Reorientation of materials

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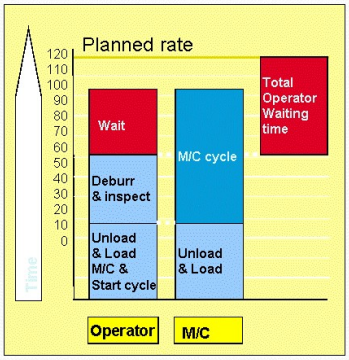
Waiting

Waiting time results from failure to synchronise activities



- Waste of waiting is any idle time produced when two interdependent processes are not completely synchronised
- Operators are kept waiting, or simply work slowly whilst the machining cycles
- Waiting results from:
  - Poor man / machine coordination
  - Long changeovers
  - Unreliable processes / quality
  - Batch completion, not single piece transfer between operations
  - Time required to perform rework

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Overproduction

Avoid overproduction by balancing supply to demand

- Overproduction is the worst kind of waste because it causes other wastes and obscures the need for improvement
- Overproduction waste results from producing more (or faster) than required
- Overproduction is caused by
  - Large batch sizes
  - Unreliable processes
  - Unstable schedules
  - Unbalanced cells or departments
  - Working to forecast / inaccurate information not actual demand

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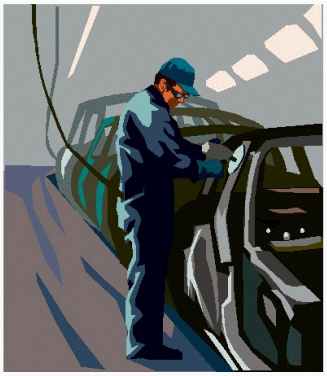
Over-processing

Clear, standardised instructions avoid over-processing



- Over processing is putting more into the product than is valued by the customer,
  - painting of unseen areas
  - unnecessarily tight tolerances
  - cleaning and polishing beyond the level required
- The goal is to do only the level of processing to match that which is useful and necessary
- Over-processing is caused by:
  - No standardisation of best techniques
  - Unclear specification / quality acceptance standards

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Defects

Right first time avoids scrap & rework

- Waste of correction includes additional work performed on a product or service
- Caused by or unclear operating procedure / specifications
- Defects are caused by
  - Inadequate training
  - Skills shortage
  - Incapable processes
  - Incapable suppliers
  - Operator error
  - Excessive stock
  - Transportation

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Skills

- Employees are seen as a source of labor only, not seen as true process experts
- People are told what to do, and asked not to think
- Employees are not involved in finding solutions, opportunities to improve our process are missed

- Common causes:
  - Management does not involve employees in problem solving
  - Narrowly defined jobs and expectations
  - Old school management, worker relationships

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LEAN TOOLS

- 5S or 6S
- Value Stream Analysis
- Poke Yoke (Mistake-proofing)
- Visual Workplace
- Just in Time (JIT)
- One Piece Flow
- Single Minute Exchange of Dies (SMED)

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BENEFITS OF 5S

- What benefits did we realize by applying 5S to our simulated workplace?
  - Quality
  - Cost
  - Delivery/Service
  - Quantitative
  - Qualitative

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THE 6S TOOL

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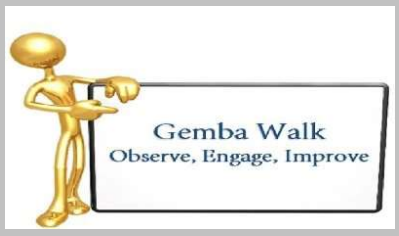
FIND THE WASTE

- Take a GEMBA walk
- Seek first to UNDERSTAND
- Look for NON-VALUE ADDED activities
- RESPECT for people



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LET'S 5S A TYPICAL GARAGE

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THE FINISHED STATE

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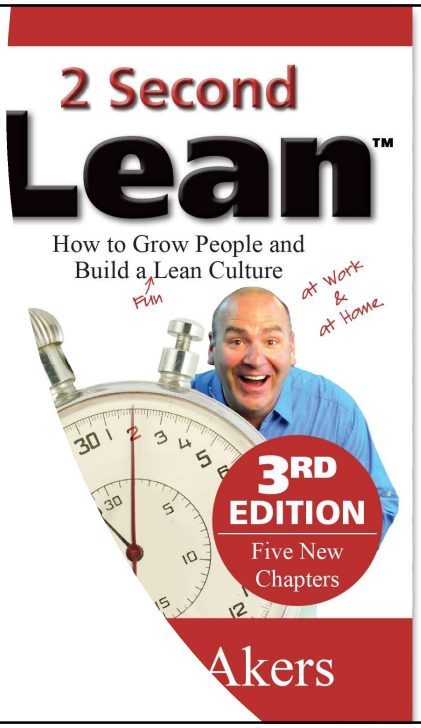
FIX WHAT BUGS YOU

- Paul Akers – Fast Cap
  - https://www.youtube.com/watch?v=NGhBiHP3pZc
- 2-Second Lean (2SL)
- https://paulakers.net



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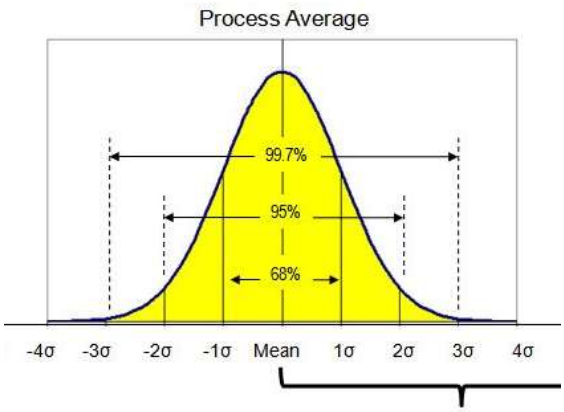

ADD IN SOME SIX SIGMA

- Structured Problem Solving
- Objective based analysis
- Eliminate or prevent non-conformances
- We need to capture information (data)

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WHAT RECORDS DO WE HAVE?

- Inspection Report
- Field Repair Data
- Testing

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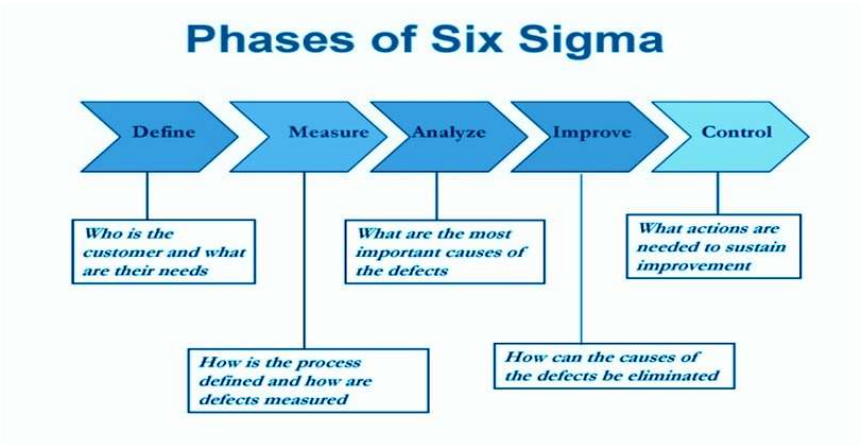
DMAIC – STRUCTURED PROBLEM SOLVING METHOD



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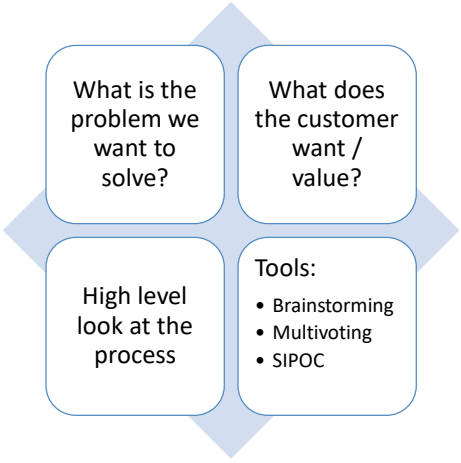
DEFINE



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SIPOC

Pizza Process

Suppliers	Inputs	Process	Outputs	Customers
• Dairy Supply Corporation • Vegetable Farmers United • Prepared Foods Corporation	• Cheese • Olives • Peppers • Dough • Sauce	• Prepare Dough • Add Sauce • Add Cheese & Toppings • Bake in oven • Remove from oven & serve	• Pizza	• Dine-in Customers • Take out Customers • Delivery Customers

What does the SIPOC for a Septic Tank look like?

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MEASURE

- Collect data
  - Check sheets
  - Inspection Reports
  - MS Excel
- Record Measures
  - Tests
  - Defects
- Tools
  - Pareto Diagram
  - Run Chart
  - Control Chart
  - Histogram
  - Critical To Quality (CTQ)

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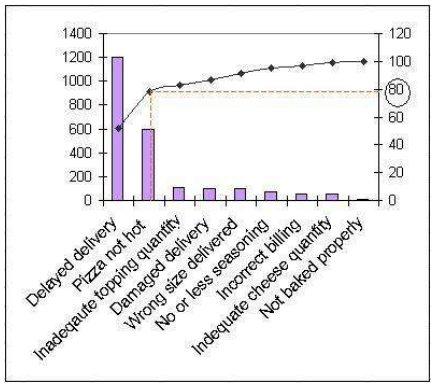
Complaint	Count
Pizza not hot	600
Inadequate topping quantity	105
Inadequate cheese quantity	55
Not baked properly	12
No or less seasoning	75
Delayed delivery	1200
Damaged delivery	100
Incorrect billing	57
Wrong size delivered	95



PARETO CHART

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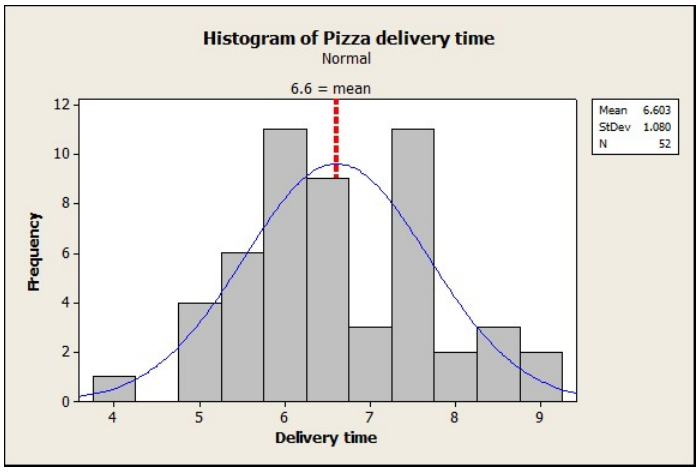
HISTOGRAM



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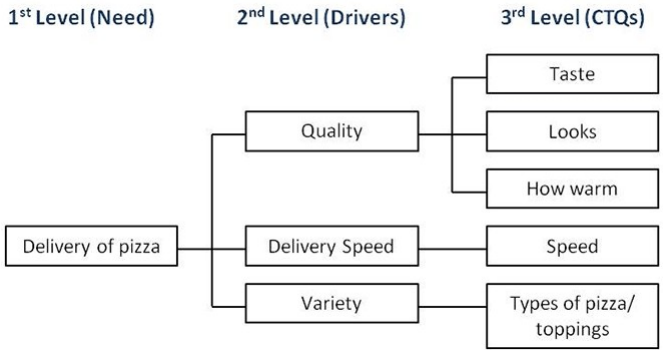
CRITICAL TO QUALITY



What does the CTQ for a septic tank look like?

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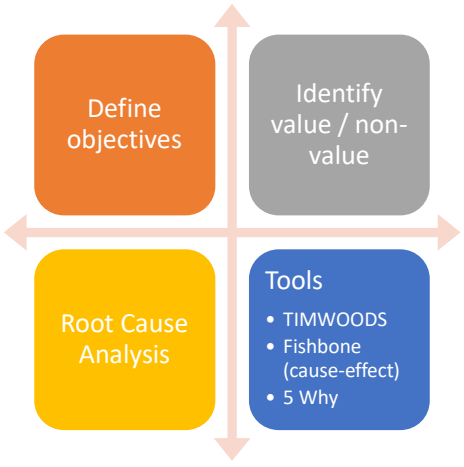
ANALYZE



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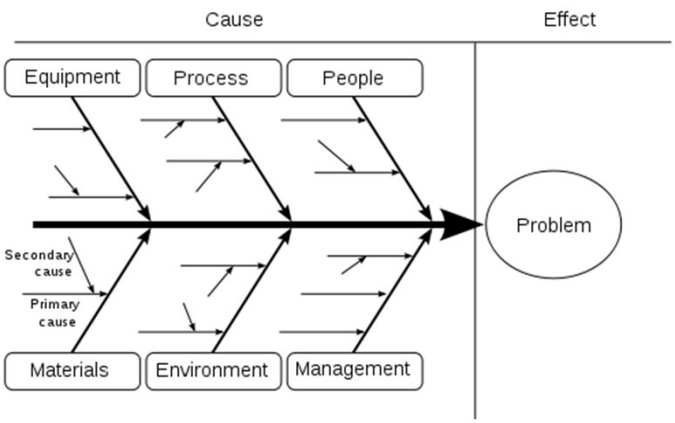

TOOLS

Cause and Effect Diagram, Ishikawa Diagram, Fishbone Diagram

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WHY IS MY TOAST BURNT?

- **Effect:** Burnt Toast
- **Main Cause Categories:**
  - People
  - Equipment
  - Methods
  - Materials

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PEOPLE

- I don't usually make the toast
  - My wife is out of town
  - I was not trained on this toaster
    - My wife assumed I was smarter than the toaster
      - Assumptions are bad!

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EQUIPMENT

- The toaster is old
  - The toaster is full of bread crumbs
    - The toaster is not maintained
      - I didn't know it mattered
      - My wife wasn't complaining about it
        - She knows what she's doing
- The settings were changed
  - A different material was used last time
  - There are no instructions

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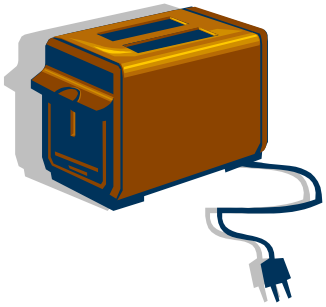
METHODS

- There are no work instructions
  - I thought it seemed easy
    - I am smarter than a toaster
      - Re-evaluate my self worth
- I didn't adjust the settings
  - Don't know what setting it should be
    - Lack of instructions



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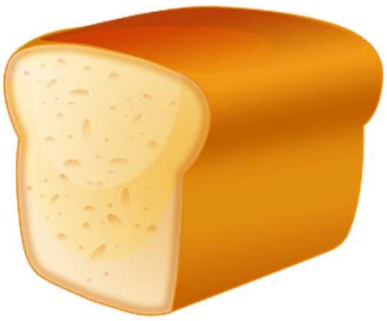

MATERIALS

- The bread is stale.
  - Didn't use it fast enough
    - Not home for breakfast
      - Leave early for work
        - Working on a special project
- The bread is thinner than usual
  - We change brands
    - Save money

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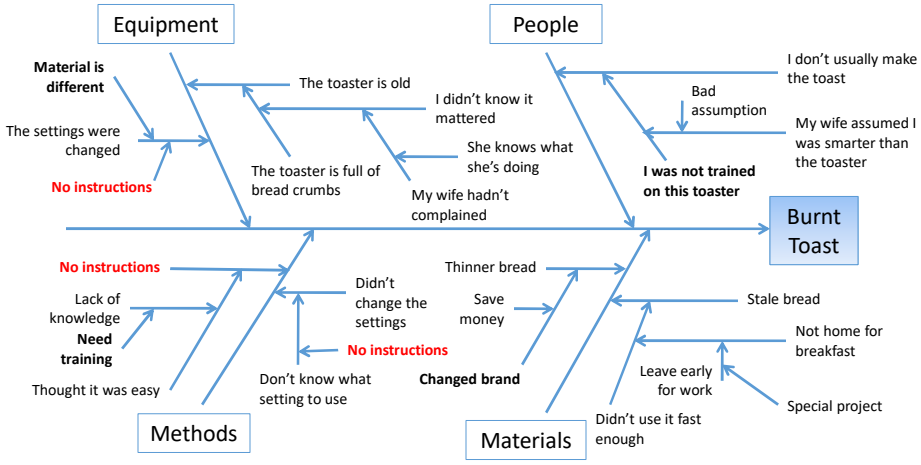
CAUSE AND EFFECT: BURNT TOAST



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5 WHY'S

- Ask "Why" 5 times
- Best used when people are involved
- Great for auditing a process to gain understanding
- Can be 4 or 6 why's

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5 WHY'S

Problem Statement: You are on your way home from work and your engine dies.

1. **Why** did your engine die?
   - *Because your car ran out of gas*.
2. **Why** did your car run out of gas?
   - *Because I didn't buy any gas on my way to work*.
3. **Why** didn't you buy any gas this morning?
   - *Because I didn't have any money*.
4. **Why** didn't you have any money?
   - *Because I lost it all last night in a poker game*.
5. **Why** did you lose your money in last night's poker game?
   - *Because I'm not very good at "bluffing"*.

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SOLUTION

- Good solution:
  Stop bluffing
- Better solution:
  Set a dollar limit
- Best solution:
  Stop playing poker for money

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IMPROVE

- List 3 – 5 Solutions
- Select one to try
- Roll it out (try it!)
- Evaluate and correct
- Tools:
  - Brainstorming
  - S.W.O.T.
  - FMEA
  - Project Plan

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CONTROL

- Verify
- Document and standardize
- Celebrate
- Tools:
  - Control Chart
  - Control Plan
  - Balanced Scorecard
  - Mistake Proofing

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MISTAKE PROOFING

Poka yoke:
the Japanese work for mistake proofing

- Go / no-go gauge
- Warning lights
- Color coding

Proportionate to the risk and/or cost of a future failure

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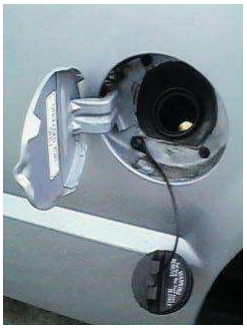
EXAMPLES OF POKA-YOKE



Tethers and holders

Lights and gauges

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POSTED SIGNS AND INSTRUCTIONS

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- Stop lights
- Spell Checker
- “Lights on” warning buzzer
- “Auto-off” on coffee maker
- Pictures and signs
- Color coded bins and instructions

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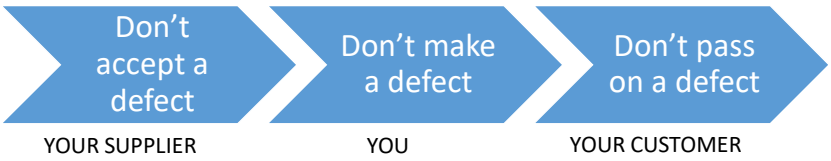
THREE RULES OF POKA YOKE

An error proofing system should take into consideration these three simple rules:



Ideally, design the product so that the product cannot be assembled wrong.

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STATISTICAL PROCESS CONTROL

Descriptive Statistics

Descriptive Statistics	
Mean	6215.60
Standard Error	15.91
Median	6210.00
Mode	6110.00
Standard Deviation	79.53
Sample Variance	6325.67
Kurtosis	-1.23
Skewness	-0.06
Range	240.00
Minimum	6090.00
Maximum	6330.00
Sum	155390.00
Count	25.00
Largest(1)	6330.00
Smallest(1)	6090.00
Confidence Level(95.0%)	32.83

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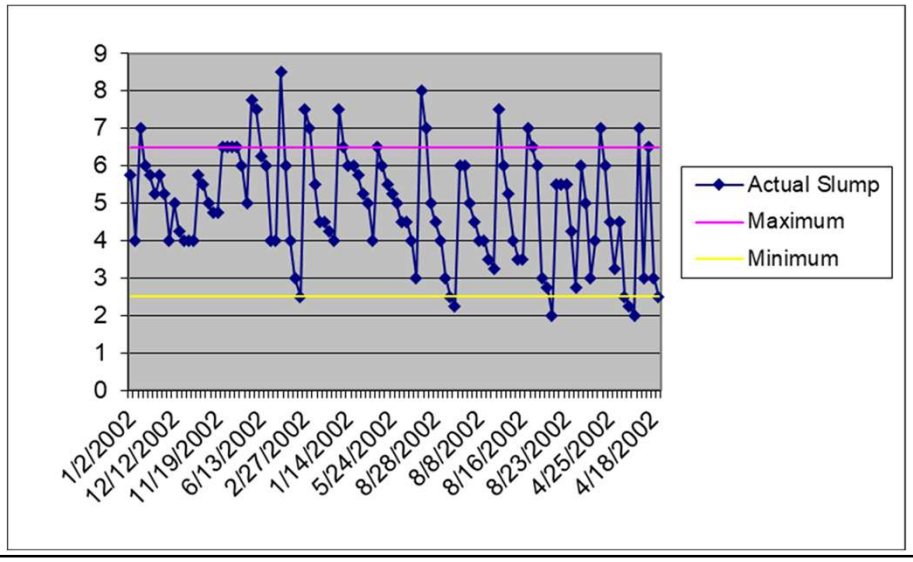
CONTROL CHARTS



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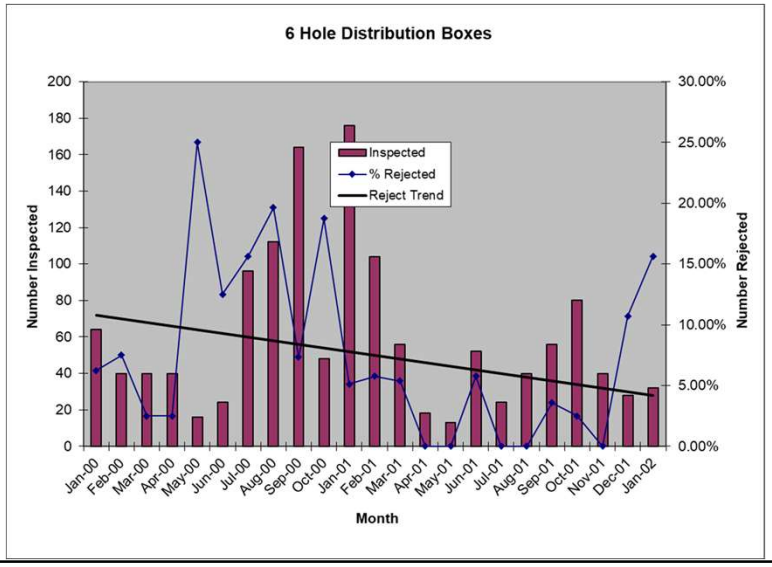
CONTROL CHARTS



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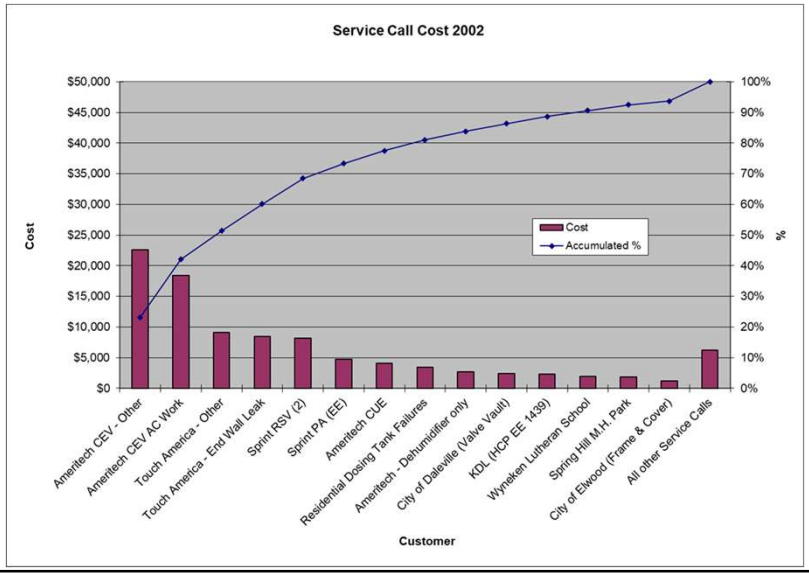
PARETO CHARTS



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CONCLUSION

- Find and eliminate waste in the process
- Mistake proof the process
- Make small improvements constantly
- Use inspection records to record information
- Compile data to see trends and runs
- Use the data to make decisions to get better
- Reduce cost | Increase speed | Improve quality

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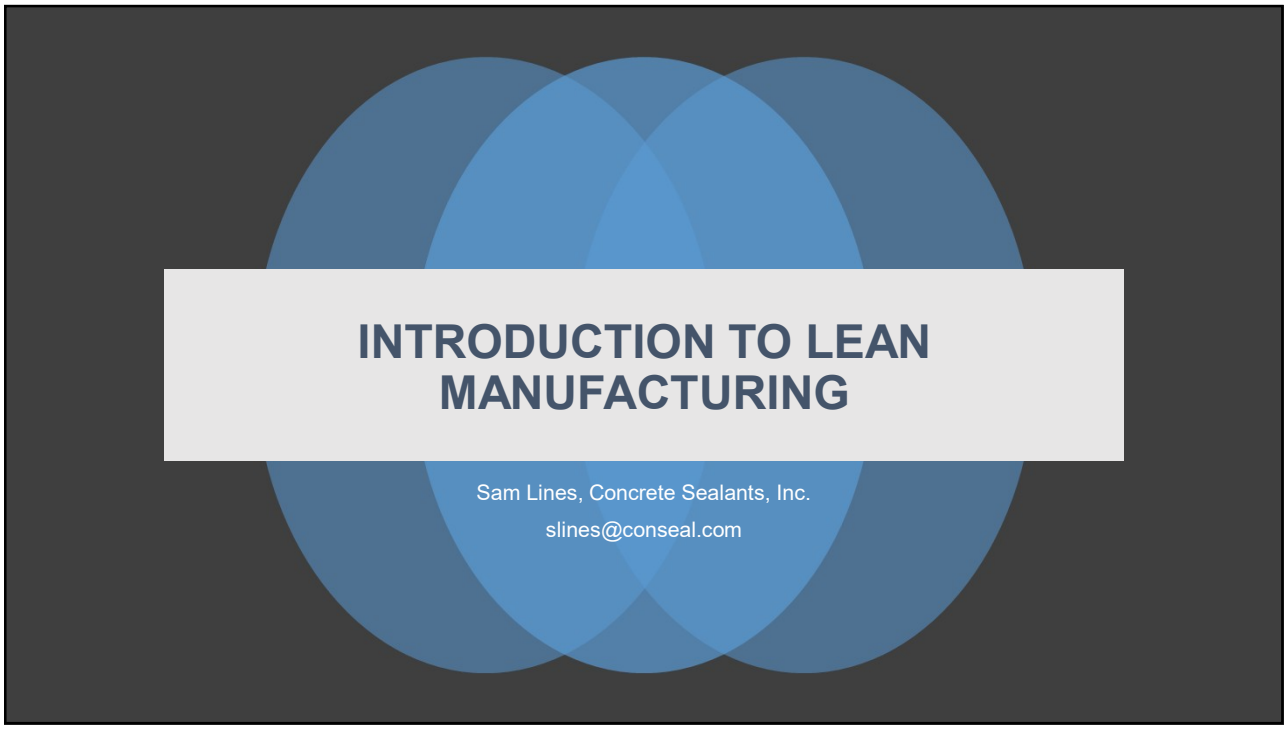
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