Supply Chain Alignment
Module 5.2

Kevin Lennox, LFM '06
Dave Penake, LFM '06

Chris Schechter, LFM '98 – Axcelis Technologies

Presentation for:
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Characteristics of Effective Supply Chains

- Customer focus
- Open avenues of communication within and between corporations
- Investment in technology that enables supply chain management
- Performance measurement and competitive benchmarking

As the economy changes, as competition becomes more global, it's no longer company vs. company but supply chain vs. supply chain.

Harold Sirkin, VP Boston Consulting Group

Common Disconnects

Social Factors

- Ineffective and irregular communication
- Inconsistent operating goals
- Organizational culture and structure
- Resistance to change – lack of trust
- Lack of managerial commitment

Technical Factors

- Inadequate information systems
- Constrained resources
  - Technical
  - Financial

Disconnect Situations

- **Within Organization**

  Design vs. Manufacturing – Conflicting Priorities

  Background: Production engine fan flow starts to trend downward. A root cause investigation identifies fan blade twist angle as the key driver.

  Disconnect: Design engineer needs to obtain and evaluate twist angle data from the supplier (internally owned). The manufacturer is focused on meeting production schedule and is unwilling to sacrifice the time and resources to generate the data.

  Impact: Upper management gets involved and the investigation suffers significant delays.

- **Outside of Organization**

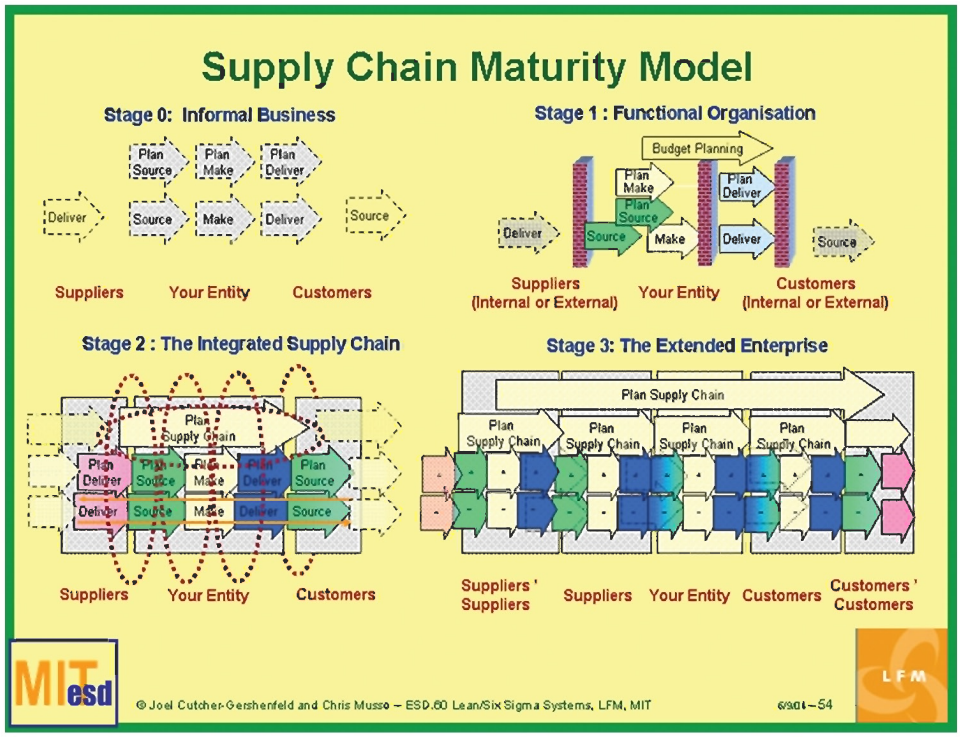
  Revenue Sharing Partners – Inadequate Information Sharing

  Background: Company A purchases engine sub-assemblies from company B. Co. B discovers a design flaw in one of their own models.

  Disconnect: Co. B engineering team introduces a new design to address original flaw. Co. B contacts Co. A to offer redesign only to find out that Co. A had already discovered and resolved the same issue without collaborating.

  Impact: Redundant work done. Lost time and money associated with redesign.

Supply Chain Maturity Model



Appendix: Instructor's Comments and Class Discussion on 5.2

- Supplier Certification Systems
  - ISO 9000/9001, ISO 14000, other systems relate to six sigma, and often force similar discipline to the system.
- Long term v. Short Term Suppliers in the Extended Enterprise
  - How does a long term supply relationship relate to six sigma?
    - Does it enhance or hurt the six sigma program?
  - What are the advantages and disadvantages of short-term suppliers?
- The SCOR model may be too generic for six sigma

Standardized Work
Module 6.1

Jessica Dolak, LFM '06
Ben Lathrop, LFM '06

Kris Harper, LFM '02, Blinds To Go
Rob Spina, MIT '99, Blinds To Go

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Why Standardized Work?

- Provides a basis for employee training
- Establishes process stability
- Reveals clear stop and start points for each process
- Assists audit and problem solving
- Creates baseline for kaizen
- Enables effective employee involvement and poka-yoke
- Maintains organizational knowledge

Source: *Pascal Dennis, Lean Production Simplified (New York:Productivity Press, 2002)*

JB's Pizzeria Exercise – Typical Results

- Typical results from the exercise are:

Group I – Makes pizzas without standardized work (SW)

1. Pizzas are "creative" with lots of variety in size, shape, and design
2. Group I tends to take the longest time to complete the exercise

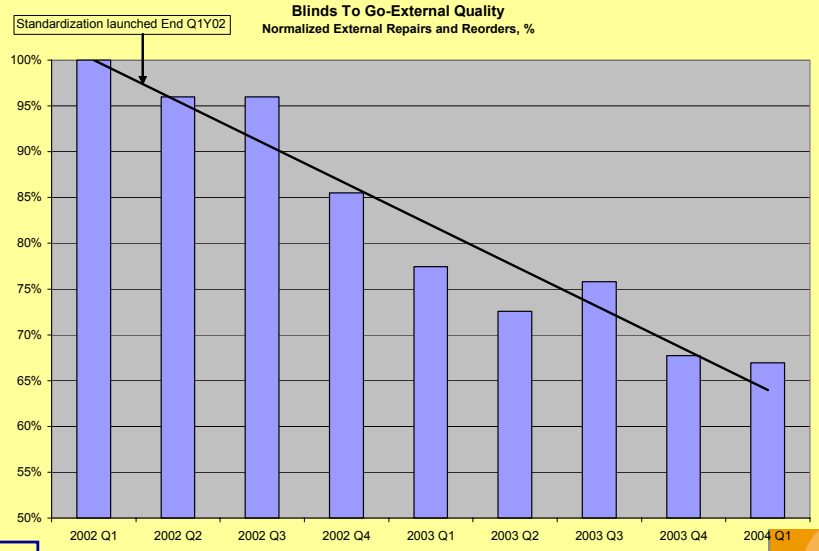
Group II – Makes pizzas after SW implemented

1. Pizzas closely resemble the desired product quality but with some minor variations
2. Group II tends to take nearly the same amount of time as Group I

Group III – Makes pizzas after SW and kaizen improvement

1. Pizzas look like "prototype"
2. Group III tends to finish earliest

Blinds To Go Example



Disconnects & Misconceptions

- Standardized work is sometimes mistaken to be a static work process
- Workers may feel threatened that their jobs are at risk and therefore may not participate fully in optimizing the process
- Standardized work may not show immediate results due to other factors:
  - worker attrition
  - additional training requirement
  - improvement cycle just beginning

Appendix: Instructor's Comments and Class Discussion for 6.1

- Standardized work is a core foundation for almost all other principles of lean/six sigma
- One of the big differences between lean and mass: the source of the standardized work
  - Lean: standardized work comes from teams, is constantly improved
  - Mass: standardized work imposed by management and industrial engineers, very rigid
- Important goal of standardized work: eliminating wasteful motion

ANDON Response Systems
Module SPL 6.3

Brooke Kahl and Andrea Sieg Jones

Cobra Motorcycles:
CEO Sean Hilbert, LFM '98
COO Jamie Flinchbaugh, LFM '98

Presentation for:
ESD.60 – Lean/Six Sigma Systems
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Andon Defined

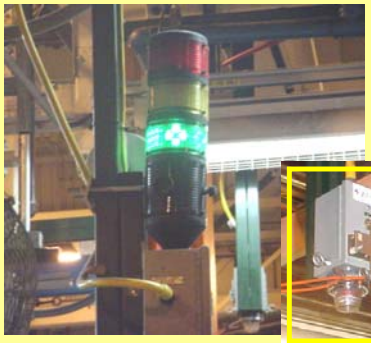
Japanese for light or lantern (orig).[1]

"A system to surface and solve problems as they occur."[2]
(Jamie Flinchbaugh, COO Cobra Motorcycles)

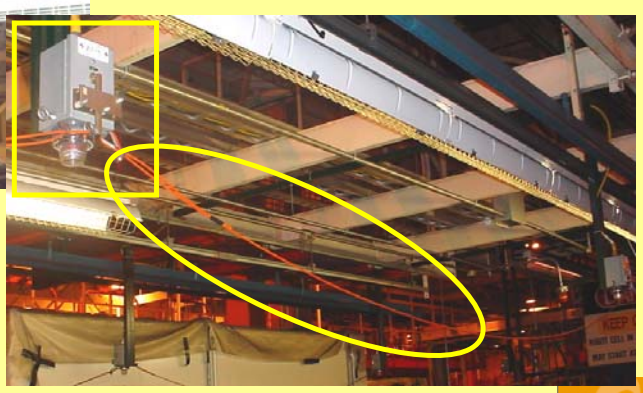
In Lean Systems, it is part of the "Jidoka" value of "autonomation" or "automation with a human touch." It is the value to "stop and respond to every abnormality." [3]

A cord, signal, light, bell, music alarm, triggered by an operator confronted with a non-standard condition. [4]

Andon Devices at GM Assembly Plant

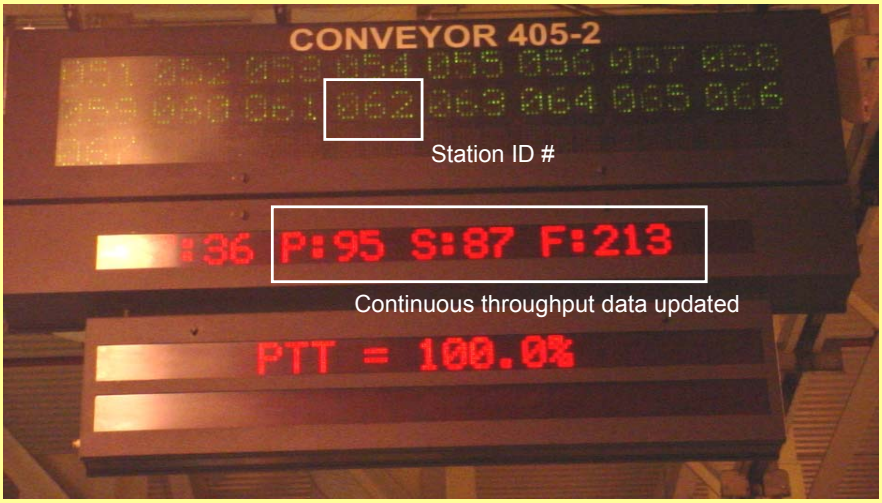


Stack light – red/yellow/green



Pull cord w/ indicator light

Andon Devices at GM Assembly Plant



"Bingo board" (Andon board)

Disconnects With Andon

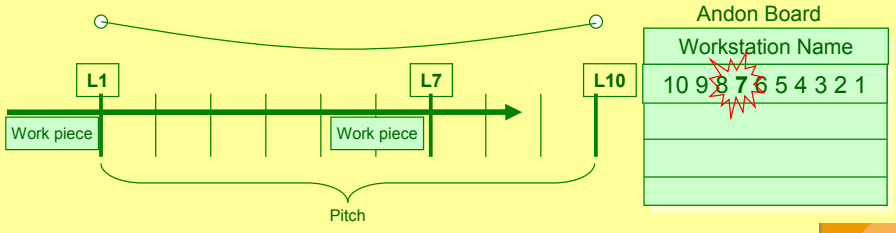
- **Technical Factors**
  - Andon equipment or process gives false signal or breaks down
  - Small problems can grow to large issues downstream if Andon not used correctly
  - It is difficult to root cause a problem much later than its occurrence
  - Incorrect assumption that Andon must consist of boards/lights/etc.
  - Companies can track data but may not actually solve problems
- **Social Factors**
  - Operator not properly trained
  - Operator abuses system
  - Operators can feel defensive when approached about problems in their area.
  - People see defects from upstream but may not highlight it.
  - Over-reliance on Andon systems and neglect to communicate verbally.
  - One responder has too many issues to resolve at once and gets frustrated

Appendix: Instructor's Comments and Class Discussion on 6.3

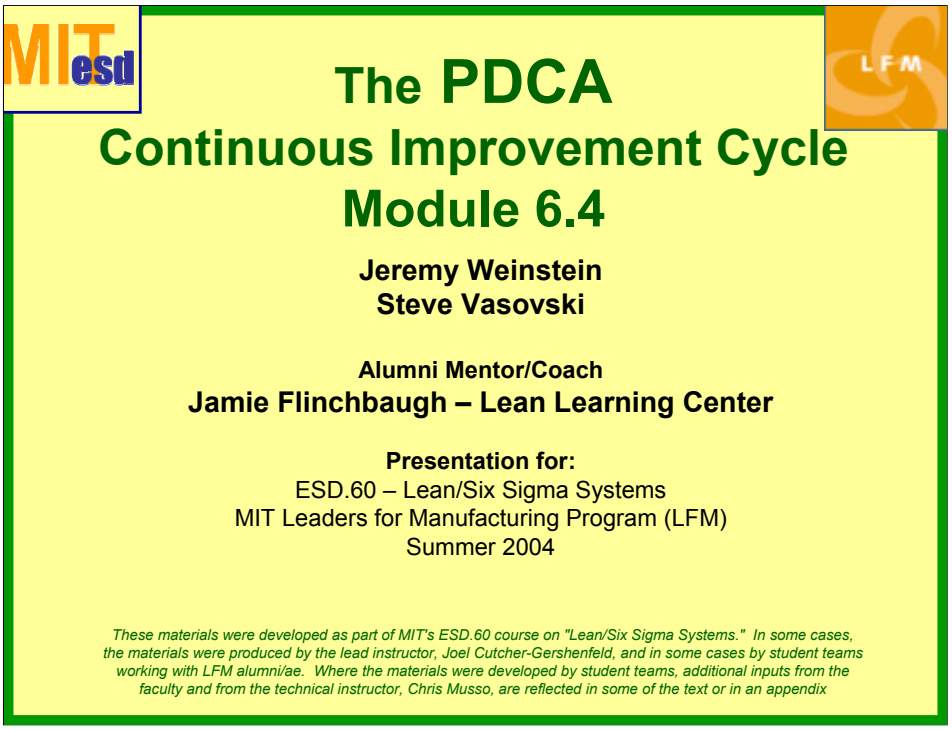
- Key concept: Andon is a tool to reveal problems
- Andon is not a solution in itself
- Implementation of Andon in a "brownfield" setting is very different than in a "greenfield"
  - One strategy involves establishing "Control Points" to bring the most common source of defects into "control" after which it is subject to the Andon and the Control Point moves to the next one.

Additional Andon Application Information

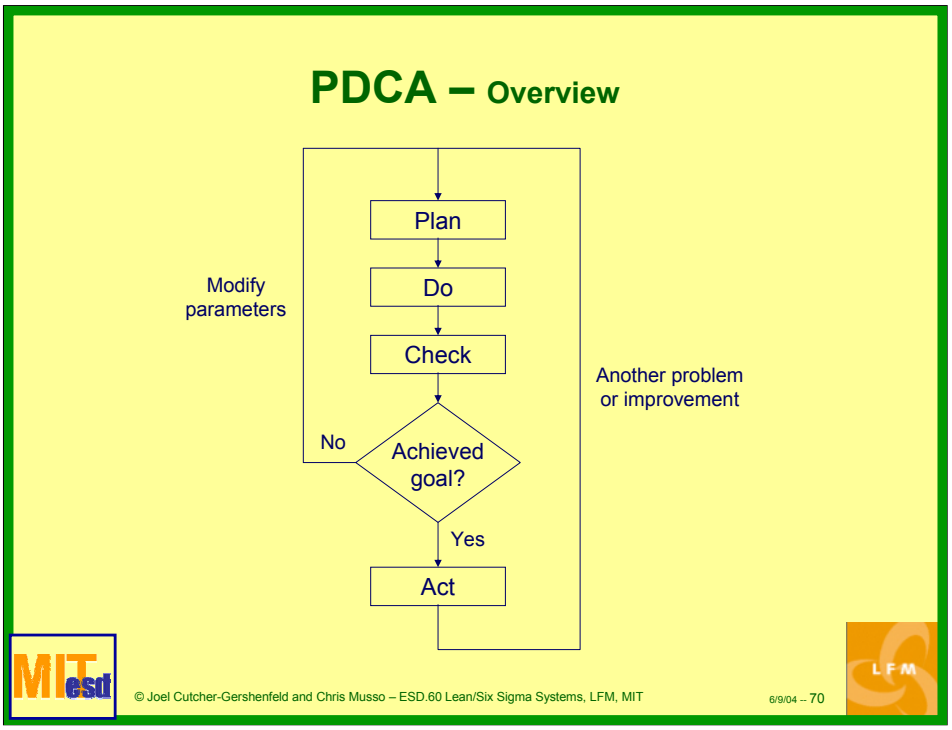
- The illustration below shows the work **pitch** (or the station in which an individual must perform all work) subdivided into ten lines(L1 – L10). (At Toyota, these lines are actually painted on the floor or indicated with heavy tape that can be moved.) The heavy arrow indicates the work flow. The curved line represents the **Andon Cord**. The blue box represents an **Andon board** which will typically hang from the ceiling in a visible area. The numbers on the Andon board correspond to the ten lines in the pitch.
- As the work piece flows through the pitch, the team members perform their work tasks. If a team member finds a problem, he or she pulls the cord. The number on the Andon board corresponding to the L station lights up. The work piece continues to move through the pitch unless the team leader either pulls the cord to stop the line (which affects all upstream and down stream work stations) or to turn off the alert light after the problem is solved. In another instance, if the team member reaches L7 and has not completed 70% of the work, he or she pulls the Andon cord to get help.



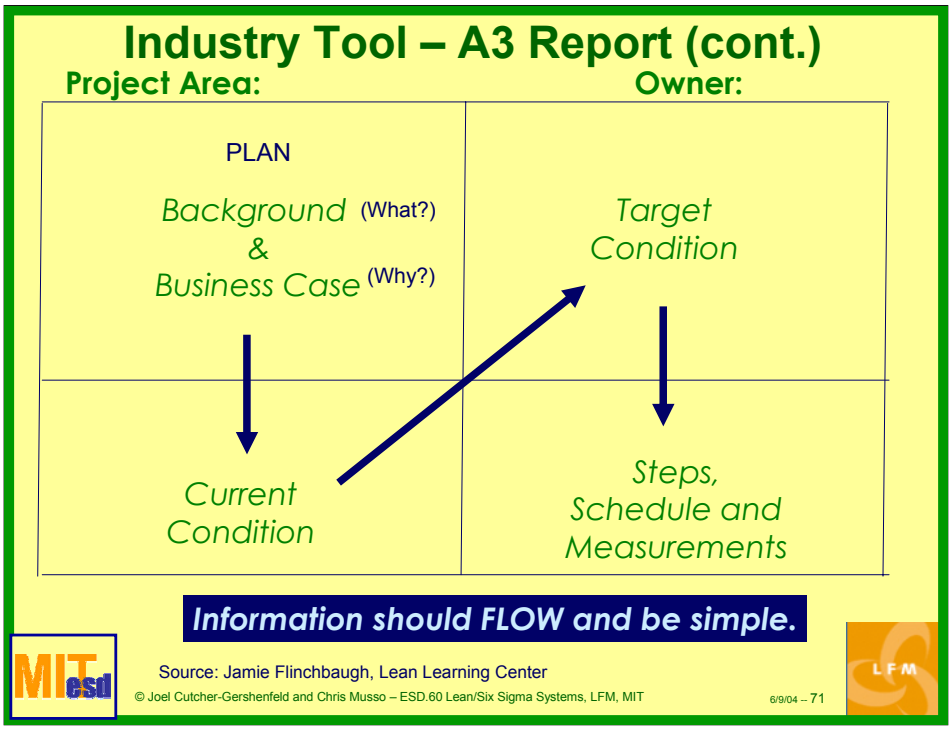
Source: Dr. Jon Yingling, University of Kentucky as presented in LAI Lean Implementation Fieldbook, developed by Michael Chapman, Joel Cutcher-Gershenfeld, Gregory Manuel, Gina Mile, Jeanine Miller, Mike Packer, Robert Reifenberg, and David Veech.



Jamie Flinchbaugh – one of the founders of the Lean Learning Center - lean consulting



Overview that elaborates decision process in a flow chart.



Top left - Background (what), Business case (why) – this is the plan step

Bottom right – how you are going to get there and what you are going to use to measure against hypothesis

Common Disconnects in Industry

Technical Factors

- BIG "**P**"$_{DCA}$ – Overplanning
  - Team gets stuck in planning cycle – try to confirm beliefs in planning whereas lean model confirms beliefs in check
- LITTLE "P"**DCA** – Underplanning
  - Missing experimental hypothesis: no "why".
- Things work well for reasons beyond understanding with no knowledge of what worked and why.
- The hypothesis is not validated.

Social Factors

- Constrained resources and improper training cause PDCA to begin and end at "Do".

Appendix: Instructor's Comments and Class Discussion from 6.4

- Problems can stem from overplanning or underplanning—important to find the right PDCA balance
  - A decade to learn to "Plan," a decade to learn to "Do" . . .
- Constrained resources can lead to a lot of doing, and not much else
- Documentation is key to PDCA, so that knowledge can be recorded and internalized

5S & Waste Walks
Module 7.1

Rebecca Cassler Fearing & Hong Tuyet Hong
Graduate Students, MIT Leaders for Manufacturing

Eric Narvarez – Dell Inc.
Operations Manager, Dell Server Production

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5S Definitions

1. ***Sort (Seiri)***
   - Remove all unnecessary items.

2. ***Set (Seiton)***
   - Make all necessary items easily accessible.

3. ***Shine (Seiso)***
   - Clean and inspect area.

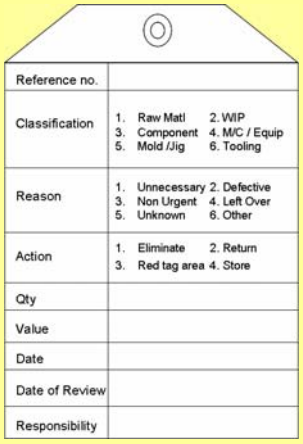
4. ***Standardize (Seiketsu)***
   - Establish standards and maintain performance.

5. ***Sustain (Shitsuke)***
   - Continually improve. Integrate 5S into culture.

Eliminate Excess with Waste Walks

- Waste Walks
  - Utilized during “Sort” phase of 5S.
  - Identify material that has not been used for one month.
  - Mark excess materials with a “Red Tag.”
- Red Tag Materials
  - Evaluate all tagged materials.
  - Properly process material and remove from work space.

Sample Red Tag from Dell



Reference no.	
Classification	1. Raw Matl 2. WIP 3. Component 4. M/C / Equip 5. Mold /Jig 6. Tooling
Reason	1. Unnecessary 2. Defective 3. Non Urgent 4. Left Over 5. Unknown 6. Other
Action	1. Eliminate 2. Return 3. Red tag area 4. Store
Qty	
Value	
Date	
Date of Review	
Responsibility	

Validating 5S Performance

- Audits should be conducted regularly to assess performance.
- Example audit questions from Dell Inc.
  - Created with input from factory associates.
  - Utilized during weekly 5S audits.

Item #	Section 1. Sort (removal of unneeded items)
1	Is any equipment that is out of service properly locked out and tagged out?
2	Has all unused equipment been removed from the area?
3	Is the work area neat, and orderly?
4	Are all items without legs, wheels or pallets removed from the floor?
Item #	**Section 2. SET IN ORDER (designating proper locations for needed items & easy access)**
5	Are all racks and shelves labeled and used properly?
6	Is all equipment stored and maintained properly?
7	Are storage/filing cabinets properly labeled and
8	Are waste/recycle collection containers labeled?
Item #	**Section 3. SHINE (keeping the area clean)**
9	Is all equipment free of temporary fixes or modifications?
10	Are cleaning materials stored properly?
11	Are all floor mats clean and in good repair?
12	Is the area free of dust/dirt/trash?
13	Is the area free of unauthorized food or drinks?
Item #	**Section 4. STANDARDIZE (regulate & continuously improve methods)**
14	Are all devices and machinery functioning properly?
15	Are fork truck drivers using their horns?
16	Is posted informationup-to-date?
17	Are all workstations consistent in layout?
Item #	**Section 5. SUSTAIN (follow the 5S naturally)**
18	Can associates explain their role in 5S?
19	Are there documented weekly 5S audits?
20	Do associates know their emergency event procedures?

Disconnects

- Social Factors
  - Greatest success requires participation by associates and management.
  - Change perspectives: 5S is more than housekeeping.
  - Consistent application is required for culture change.
- Technical Factors
  - Need a true 5S expert in operations.
  - Need to train organization on 5S concepts and benefits.

Appendix: Instructor's Comments and Class Discussion on 7.1

- Supporting Infrastructure is key to make 5S work
  - Management commitment
  - Visual display systems
  - 5s Audit
  - 5s Education
- A 5s expert is a key resource for a factory
- This is a great topic for which leaders can become teachers early on

Preventive Maintenance Principles
SPL 7.2

Scott Couzens, LFM '06
Scott Hiroshige, LFM '06

Erik Smith, LFM '03 – Intel Corporation

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Types of Maintenance

- Breakdown Maintenance:
  - Waiting until equipment fails before repairing or servicing it
- Preventive Maintenance (PM):
  - (Time-based or run-based) Periodically inspecting, servicing, cleaning, or replacing parts to prevent sudden failure
  - (Predictive) On-line monitoring of equipment in order to use important/expensive parts to the limit of their serviceable life
- Corrective or Predictive Maintenance:
  - Improving equipment and its components so that preventive maintenance can be carried out reliably

When Does PM Make Sense?

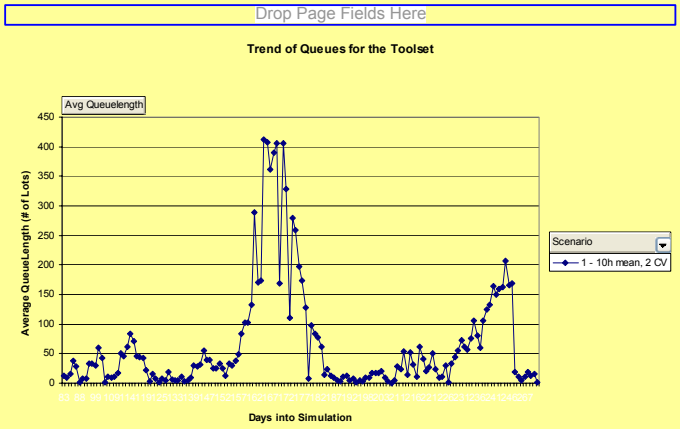
- PM makes sense when the cost of doing PM is less than the cost of NOT doing PM.

PM makes sense if $C_{DoingPM} < C_{NotDoingPM}$

- $C_{DoingPM}$ = f(hours of not running equipment, loss in employee morale from doing PM instead of "real work", materials and man-hours consumed in PM, potential for making things worse, etc.)
- $C_{NotDoingPM}$ = f(cost of losing/reworking a failed batch (unless PM makes no difference in preventing the failure), materials and man-hours spent repairing equipment, loss of equipment lifetime, loss in employee morale from NOT doing PM, reduced employee familiarity with equipment, etc.)

PM Durations: Simulation 1

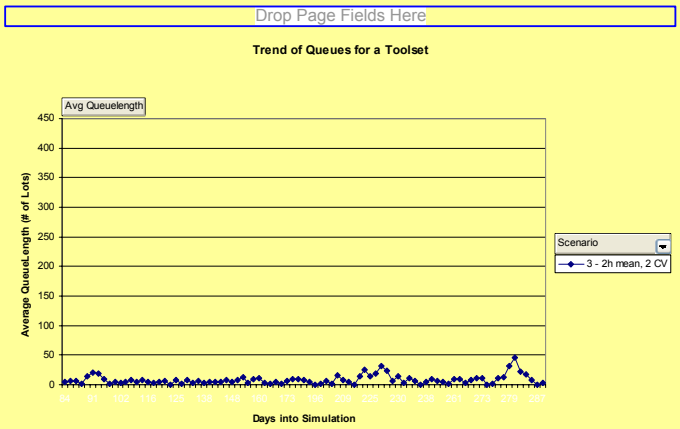
- Simulation of equipment with a 10 hour average PM duration, std dev 20 hours (85% availability)



Data from a simulation run at Intel Fab 11X.

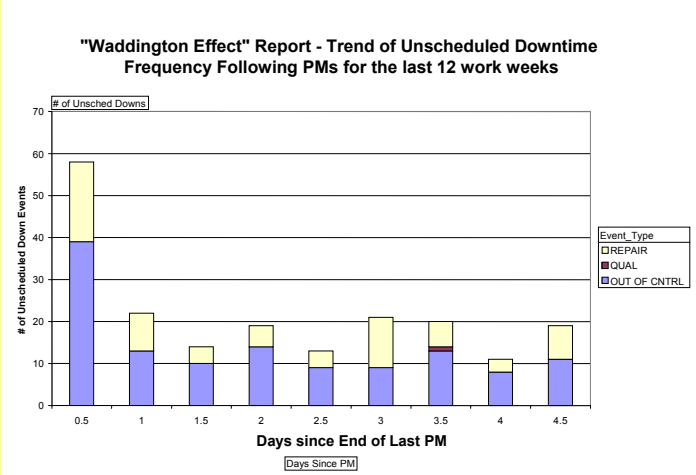
PM Durations: Simulation 3

- Simulation of equipment with a 2 hour average PM duration, std dev 4 hours (85% availability)



Data from a simulation run at Intel Fab 11X.

The "Waddington Effect"



- Impact of Waddington Effect = 1.4% Availability

Data from a set of production tools at Intel Fab 11X.

Challenges to Implementing Preventive Maintenance

- **Social Factors**
  - Organizations are frequently structured in ways that promote local optimums (cost, shiftly output goals, etc.)
  - The benefits of preventive maintenance are not always well understood
  - The focus on minimizing maintenance costs has to shift to maximizing overall organizational performance
- **Technical Factors**
  - Breakdown maintenance is typically cheaper than preventive maintenance in the short-term
  - Under-trained technicians can cause more damage than they prevent

Appendix: Instructor's Comments and Class Discussion for 7.2

- PM is an important tool for establishing stability necessary for other lean elements:
  - Andon, 5s, etc.
- How do you escape the crisis management whirlpool?
  - Social disconnects:
    - Change the mindset of management, maintenance group from reaction to prevention
    - May need to be done in steps

Lean Machine Tooling
Module 7.3

Authors: Greg Williams and Alexey Salamini

Alumni Mentor: Wayne Firsty LFM '90, Fabric7 Systems, Inc.

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Simultaneous development of part design and production tooling

Key points:

- Most critical aspect of successful lean tooling
- Product design engineers and tooling designers must work closely during entire development process

Examples:

- Toyota body panel stamping dies - one year turnaround
- Computer chassis break-off tabs - one part turns into two

Modularity and Adaptability of Tools

Key points:

- Allow utilization of single tool for multiple processes and parts
- Anticipate future needs of process due to product design changes or improvements

Examples:

- Design of progressive tooling for stamping operations – using blanks and quick change dies
- Easily interchangeable inserts for feminine hygiene product vacuum-forming to create different sizes

Common Disconnects and Pitfalls

- **Technical Factors**
- What are you optimizing for?
  - Time
  - Cost
  - Flexibility
  - Volume
- Solutions are not always the same!

- **Social Factors**
- Implications for people involved in process
  - Need to learn new skill
  - Loss of job due to elimination of process steps; reduced manpower requirements

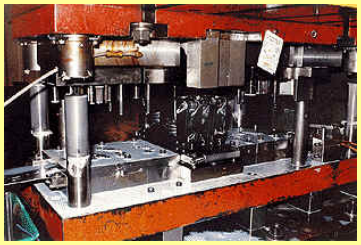
Relevant Measures of Success

- Example based on mentor's experience at Stanley Works (manufacturer of oven latches)

- Stamped sheet metal oven components with several tapped holes for attaching to adjacent components
- Originally made in two steps
  1. Stamp at 25 strokes/min
  2. Tap at 20 strokes/min
- Tapping is "bottleneck" operation
- Required 2 operations, 2 people

Relevant Measures of Success

- Stanley Works oven latch example (cont'd)



- Modified process to utilize in-die tapping of holes
  - Cam converted linear motion of drill press to rotary tapping action
  - Completed both steps at same time
- Slowed stamping action to 22 strokes/min
  - Increased cycle time for one op
  - Opened up bottleneck
- Saved ~50% cost and ~40% time by eliminating need for second machine operation and operator
  - Increased total throughput
- Cut inventory in between steps and improved quality

Appendix: Instructor's Comments and Class Discussion on 7.3

- Lean tooling reaches beyond flexible tooling
  - Flexible tooling can be bought from any machine tool manufacturer; lean tooling is a mindset
- Lean tooling has several goals
  - Reduce tooling inventory
  - Support other lean functions
  - Minimize changeover time (between parts and between products)
  - Reduce maintenance costs
- Ford's one-hour die change
  - Recognize tangible benefits of lean tooling and continuous improvement

Maintenance/Skilled Trades Work Groups

Module 7.4

Presented by:
Jeff Baer (LFM '06) and Aimee Vessell (LFM '06)

Other Contributors:
Shawn Patterson (LFM '94) – Director of Operations Strategy, DTE
Jason Schulist (LFM '97) – Manager of Continuous Improvement, DTE

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Maintenance/Skilled Trades Defined

- **What is Maintenance?**
  - ✓ Repair function performed by skilled trades in the traditional manufacturing model
  - ✓ Can include PREVENTATIVE and REACTIVE maintenance

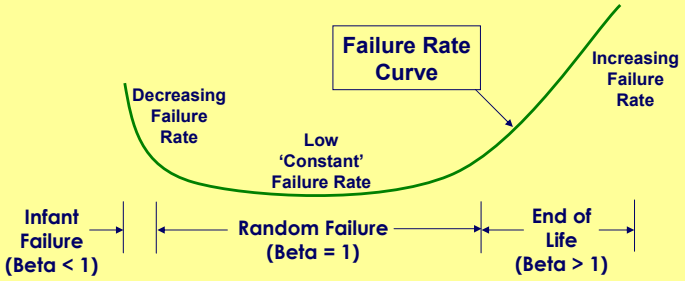
- **What are Skilled Trades Work Groups?**
  - ✓ Skill-based groups who perform maintenance tasks specific to their area of expertise
  - ✓ Ex: electricians, mechanics, millwrights, pipe fitters, tool makers, plumbers, etc.
  - ✓ Traditionally not involved directly in assembly processes (e.g., equipment operators)

Six-Sigma for Preventative/Predictive Maintenance

- **Moving from reactive to preventative**
  - At DTE → Now: 80%-20%; Goal: 20%-80%
- **Applying Six-Sigma Metrics**
  - Use historical data to predict failure
  - Weibull Plots – scatter plot of failure over time used to predict parts/equipment failure
  - Cost implications of predict vs. react
- **DTE Coal Mill Example and Reliability Analysis**

Reliability Analysis

Weibull Analysis and the Bathtub Curve



The key to success is understanding what mode you are in and what corrective actions are appropriate.

Adapted from *Weibull Analysis Short Course* provided by Shawn P. Patterson (LFM '94) currently of DTE

Historical Socio-Technical Disconnects

- **Specific tasks for specific skilled trade**
  - Ex: Stamping Plant ("Tool and Die Guy")
- **Reactive maintenance rewarded with overtime pay**
- **Management attitude that maintenance is non-value added (overhead)**
- **Minimal interaction and knowledge-sharing between skilled-trades and the rest of the stakeholders, including management**

‘Real-Life’ Challenges

- Ford/Romeo Engine Plant: Hybrid structures with some separate skilled trades work groups, some integrated groups (in the machining areas) and some cases of partial overlap structures – all driven by the nature of the task.
- Boeing/St. Louis: Production work is a skilled trade. In attempt to implement multi-skilled trades, a choice develops between using traditional skilled trade workers and ‘new’ multi-skilled workers. Supervisors default to the old trades workers. Also, JIT training for small modular skills, builds front-line flexibility, but raises issues of documentation and portability.
- Steel Mill: Wanted to go to cross-training everyone, but could not get everyone to ‘buy-in’ to cross-training unless they paid everyone cross-trained rate first. Growing pains with initial agreement.