Lean Principles

An Introduction to Lean

What is Lean?

- A systematic, continuous improvement approach to help drive value to the customer through flow improvement and waste elimination
- Also known as the Toyota Production System (TPS)

Lean Principles – Eliminating Friction

- Eliminating friction is the basic idea of Lean enterprise
- In Japan friction is called muda or waste
- A lean enterprise is one in which friction is absent

Lean Principles – The Scope of Lean

- A single plant or facility can practice lean
- Lean Enterprise includes the entire supply chain or value stream

The Key Lean Terminology

- Muda: term for waste
- Muri: term for overburden, unreasonable workloads
- Mura: term for unevenness, inconsistent workloads for workers and machines

Lean Goals

- Foster Customer Satisfaction
- Develop One Piece Flow, Pull, Just-in-Time
- Make the Cycle Time of the Process Equal to Customer Takt Time
- Eliminate Waste / Reduce Process Cost
- Continuous & Sustained Improvement
- Built-In Quality
- Cash Management & Preservation
- Flexibility & Responsiveness
- Reliability, Consistency & Predictability
- Respect for Humanity

Lean Principles – Espoused

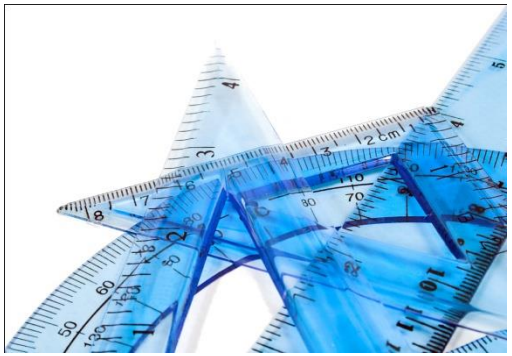
- The thought process of lean was thoroughly described in the book *The Machine That Changed the World* (1990) by James P. Womack, Daniel Roos, and Daniel T. Jones.
- In a subsequent volume, *Lean Thinking* (1996), James P. Womack and Daniel T. Jones discussed five key lean principles
- Shigeo Shingo was the mastermind behind the **Toyota Production System**, constantly experimenting and thinking on how to improve

Lean Tools & Methodologies

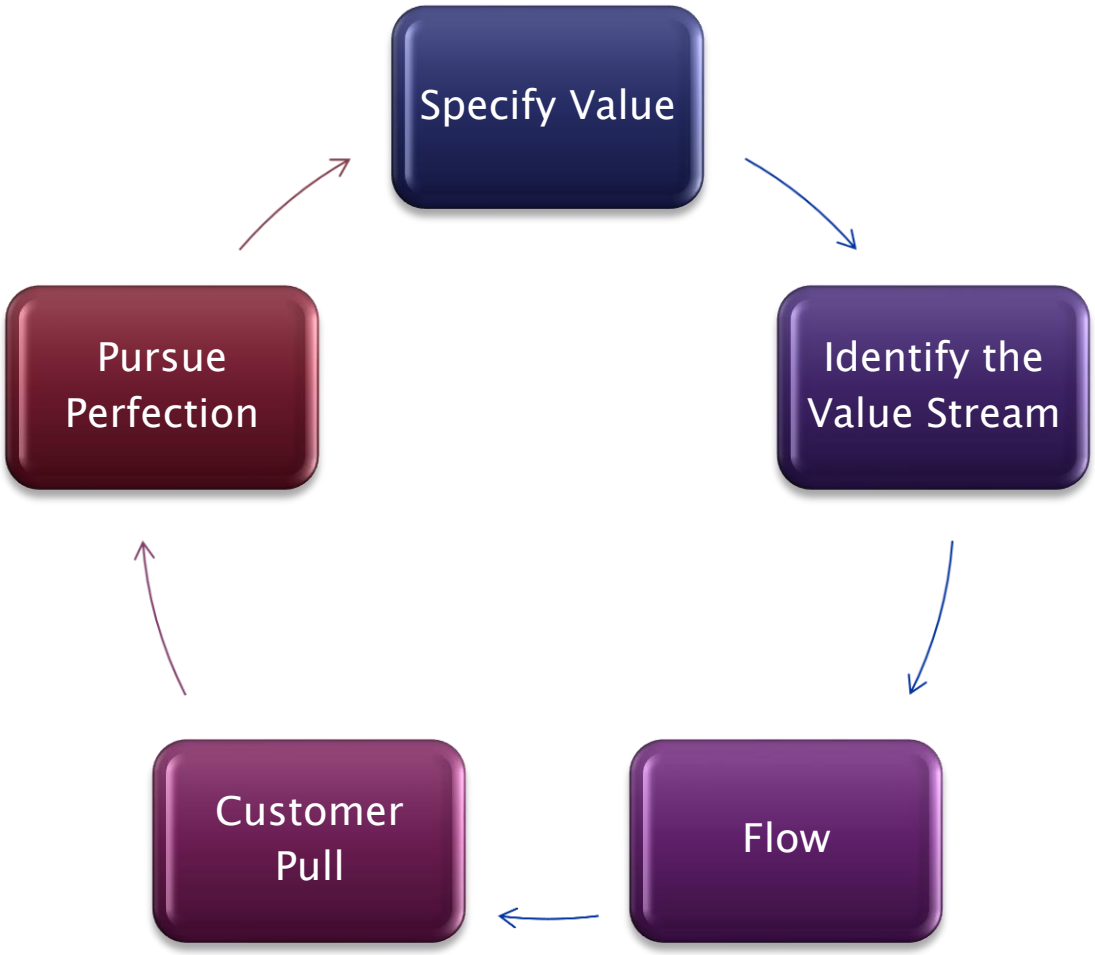
- VSM (Value Stream Mapping)
- Pull System / Kanban
- 5S / Visual Management
- Kaizen
- SMED / Changeover Reduction
- TOC (Theory of Constraints)
- Built in Quality (Jidoka)
- Total Productive Maintenance
- Target Costing

Lean Tools and Methodologies – Continued

- Error Proofing (Poka Yoke)
- Cellular Organization
- Team Building
- Cross Training
- Employee Engagement, Involvement & Development
- Mutual Trust & Respect



The Lean Process



The DMAIC and Lean Processes

Define
- Define the current problem
- Identify what's important to the customer

Measure
- Map the process
- Determine Key Process Output Metric (KPOV)
- Quantify current process performance

Analyze
- Analyze and validate causes of variation and defects
- Commit to an improvement target for the Key Output metric

Improve
- Identify solutions to causes identified
- Implement solutions and provide statistical evidence that the solutions work

Control
- Put controls in place to maintain improvements
- Provide evidence that the improvement is sustained
- Spread improvements throughout the organization

Specify Value

Identify the Value Stream

Apply Flow and Customer Pull

Pursue Perfection

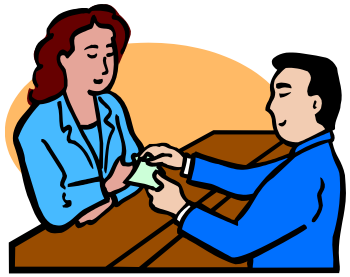
Lean Process Step 1 – Specifying Value

Lean Principle # 1: Specify Value

- Specified by the customer
- Value is defined by the final (paying) customer
- Value must be specified in terms of product and services “features” or “benefits”
- The features and benefits must meet the needs of the customer at the agreed price and time

Lean Principle # 1: Specify Value (cont'd)

- Above all, the Lean practitioner must relentlessly focus on the customer when specifying and creating value.
- Neither shareholders needs, nor senior management's financial mind-set, or any other consideration should distract from this critical first step in lean thinking.



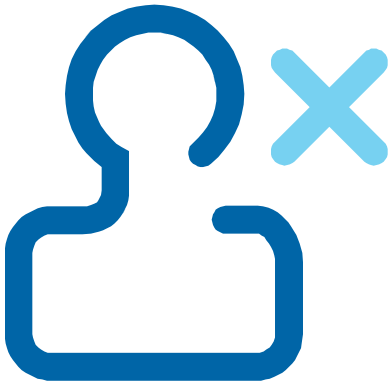
Specifying Value to the Customer

- The ultimate consumer of a product specifies what traits are valuable
  - A company cannot specify the value to its consumers
- Customer feedback is vital to determine value
  - Voice of the Customer
  - Loyalty Surveys
  - Etc.
- Kano models can then be used to understand the values that create customer satisfaction

Lean Process Step 2 – Identifying the Value Stream

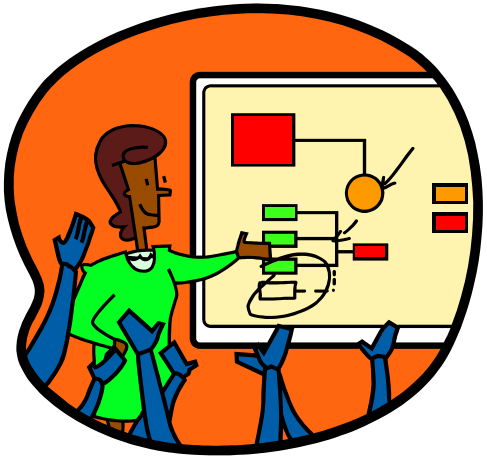
Lean Principle # 2: Identify the Value Stream

- Identify the value stream for each product or service providing that value
- Challenge all of the wasted steps that are currently necessary to provide it and remove the steps that are considered waste and non-value added



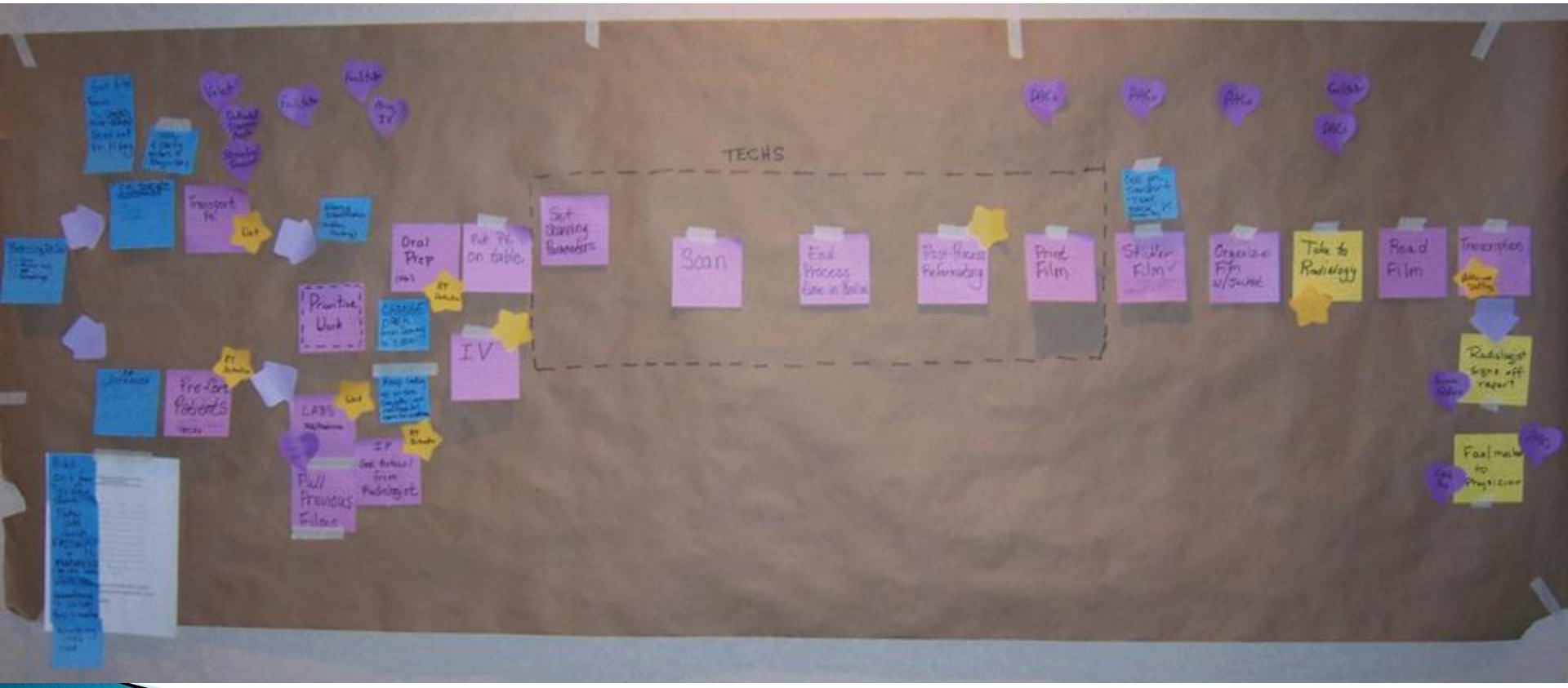
Identifying the Value Stream

- Map the current process
  - Process Map
  - Value Stream Map (VSM)
  - Data Collection on the VSM
    - Cycle Times
    - Downtimes
    - Changeover times
    - Etc.



The Process Map

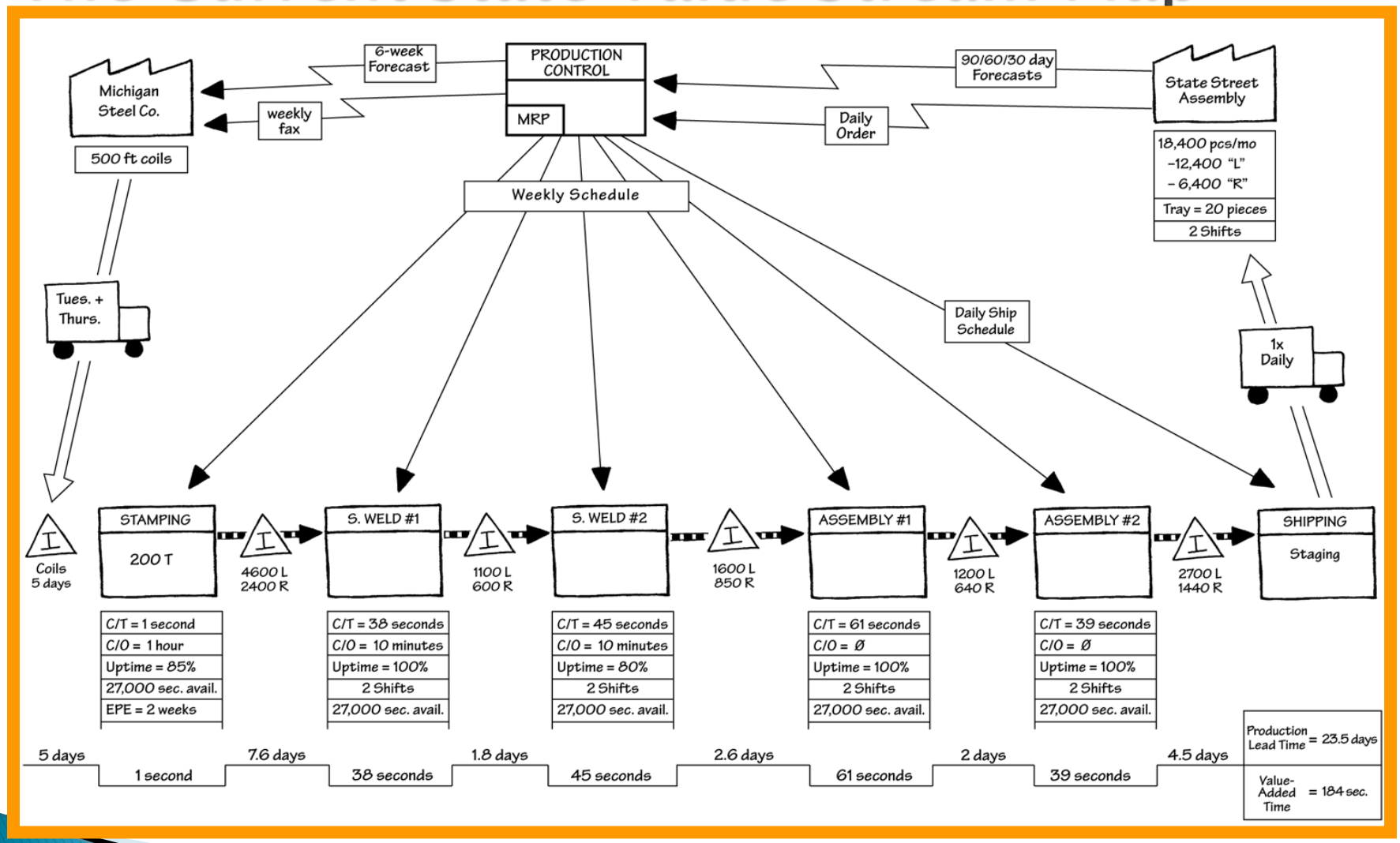
Process Map the Current State



Development of a Value Stream Map

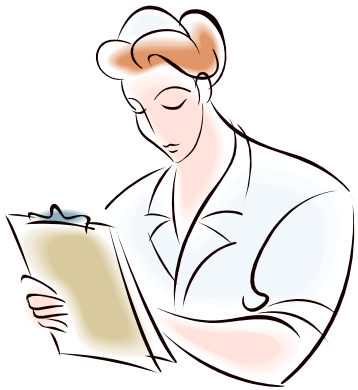
1. Select a product/service family (similar processes over common equipment)
2. Form a team
3. Understand the customer demand (for the output)
4. Map the basic process flow (high level macro-type map)
5. Map the material flow (in and out of the process)
6. Map the information flow (electronic and manual)
7. Calculate lead time
8. Detail off-line activities

The Current State Value Stream Map



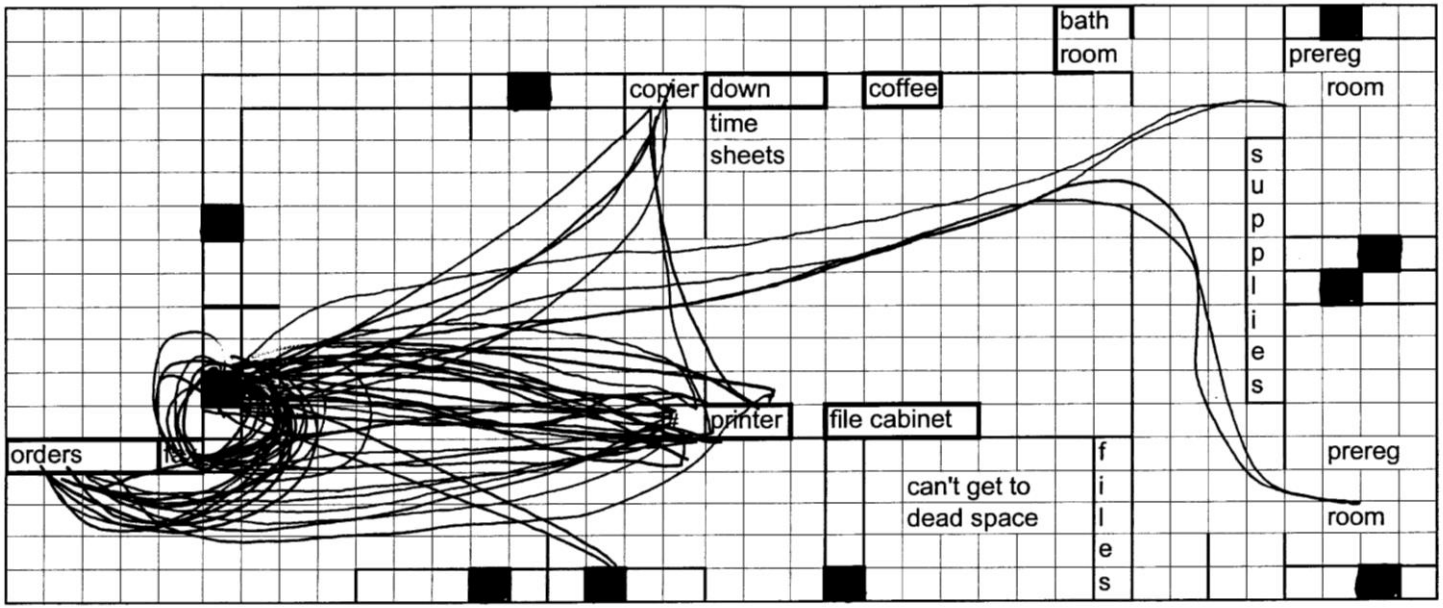
Data Collection for the VSM

- Collect data on the process including
  - Downtime, Rework, Scrap
  - Changeover times and frequencies
  - Takt time, cycle time
  - Work hours and breaks
  - WIP (work in process inventories)
  - Etc.



The Worksheets on the next 2 slides can be used to collect data on the process

Spaghetti Diagram Example



A Spaghetti Diagram tracks the movements of people and products within a work process and the associated waste

Process Observation Worksheet

Process Observation Worksheet

Name: _____ **Date:** _____

Process Observed: _____ **Page:** ___of___

#	Description of Step	Distance (steps)	Clock Time	Task Time	Wait Time	WIP	Observations & notes (problems encountered, delays, etc.)
	Start of observation:						
1							
2							
3							
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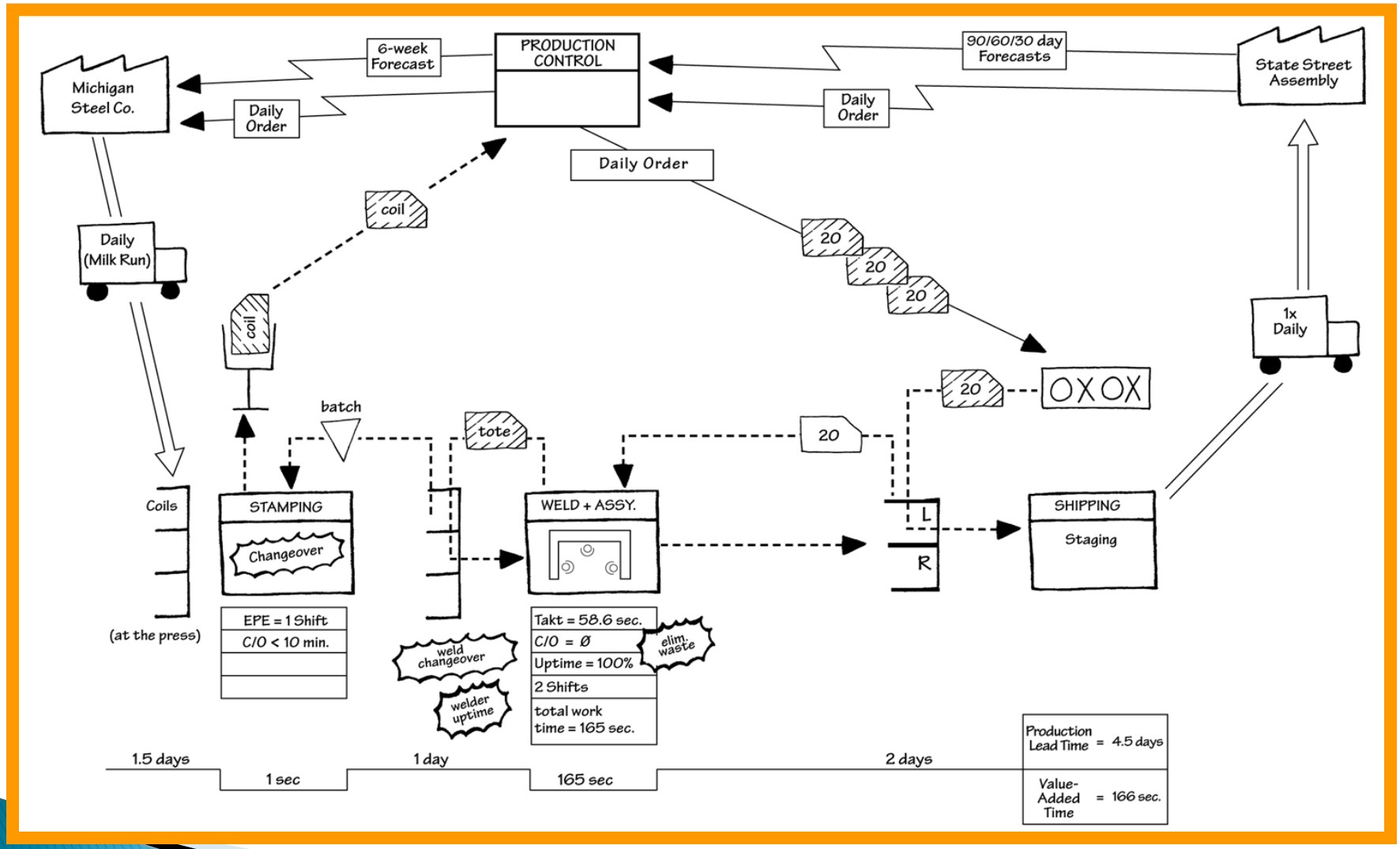
21							

For recording process observations

Developing the Future State Map

- As you identify potential areas of concern on the Current State, create a Future State VSM of what you want the process to look like
- This is a picture of what the process will look like after you have identified the future changes
- Begin with the Current State (see slide 22)
  - Label the areas for Kaizen Bursts

The Future State



A Key Lean Concept – Understanding Waste

The Ultimate Goal

- At this point, you have a map of the process
- Now you want to investigate that process further and understand what causes it to be non-Lean
  - In order to understand these causes better, it will be important to understand what parts of the process you can do without and the types of waste you may encounter
- Ultimately, you will want to eliminate those causes

Understanding Value-Added vs. Non-Value Added Activity

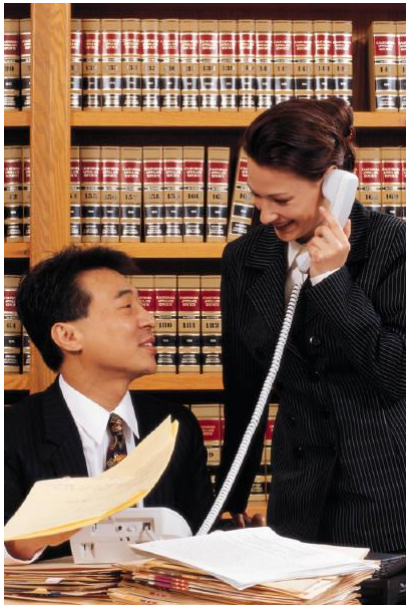
- Value-Added activity is any activity that changes the work to meet customer requirements or a specific request for which they are willing to pay.
- Non-Value added activities are not important to the customer and therefore they are not willing to pay.

Non-Value Added (NVA)

- Non-Value added activities are referred to as Muda
- Muda or waste exists in current processes in the form of:
  - Defects, Scrap, Rework
  - Overproduction
  - Waiting
  - Not Fully Utilizing People
  - Transportation
  - Inventory
  - Motion
  - Excess Processing

Business Non-Value Added

- Business Non-Value Added (BNVA) is activity that is required for business compliance
  - Regulatory
  - HIPAA
  - Sarbanes-Oxley
  - Federal Trade Commission
  - FDA
  - Others ????



Identifying NVA Activity – What is Waste?

- Any activity that consumes resources but creates no value for the customer
- Typical Wastes:
  - Time:
    - Processing delays
    - Long travel distances
  - Activities:
    - Double and Triple checking
    - Rework cycles
    - Searching for items

Identifying Waste – "DOWNTIME"

- When working to eliminate the eight types of waste:

  Remember "DOWNTIME"
- Defects, Scrap, Rework
- Overproduction
- Waiting
- Not Fully Utilizing People
- Transportation
- Inventory
- Motion
- Excess Processing

Defects, Scrap and Rework

- Waste # 1: Defects, Scrap, Rework
  - Defective products or services
  - Poor quality and yield
  - Errors and/or omissions

Examples:

- Final inspection
- Sorting for bad parts
- Rebuilding products
- Inspection and/or correction of information

Identifying Waste – Overproduction

- Waste # 2: Overproduction
  - Producing more than needed or producing faster than needed

Examples:

- Parts boxed in one area waiting for the next process
- Excess inventory in WIP or finished goods

Overproduction Consequences

- Extra space used at a customer's plant or office area
- Extra spaced used at the organization's plant or office area
- Extra raw materials in use
- Extra utilities used
- Extra transportation for the customer and the organization
- Extra scheduling costs
- Extra manpower resources being used prior to customer request

Identifying Waste – Waiting

- Waste # 3: Waiting
  - Idle time when people wait for people, people wait for machines, or machines wait for people

Examples:

- Waiting for parts from suppliers
- Waiting for an upstream process
- Waiting for inspection
- Patient waiting for an Ultrasound or MRI machine

Identifying Waste – People Utilization

- Waste # 4 : Not Fully Utilizing People
  - Associate's time, capabilities, intellect, ideas, creativity, productivity and talents are not utilized to their full potential

- Examples:
  - Restrictive job descriptions or classifications
  - Poor job placement or performing a position far below capabilities
  - Lack of suggestion or problem solving involvement opportunities
  - Organization doesn't ask for, listen to, or act on associate input

Identifying Waste – Transport

- Waste # 5: Transportation
  - Any material or information movement in excess of what is required

Examples:

- Forklift carrying pallets of WIP to the next operation
- Conveyors moving items
- Long transportation routes

Identifying Waste – Inventory

- Waste # 6: Inventory
  - Any supply in excess of customer requirements necessary to provide service just-in-time
- Examples:
  - Excess supplies
  - Excess equipment
  - Excess materials
  - Large batch processing

Why reduce inventory?

- Inventory costs money/cash
- More inventory = more handling
- Inventory deteriorates
- Inventory takes up space
- Drives improvement
  - Pull systems
  - Setup reduction
  - Turn around time

Identifying Waste

- Waste # 7: Motion
  - Any movement of people or machines in excess of what is necessary to provide required services

Examples:

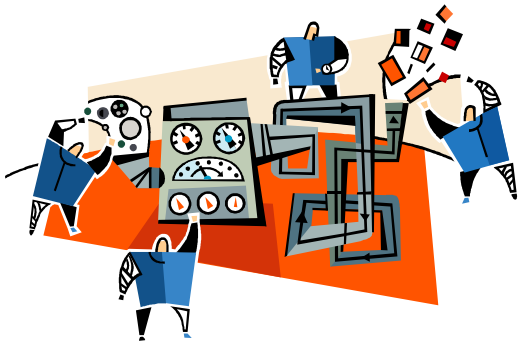
- Looking for supplies/equipment/tools to get the job done
- Looking for information
- Looking for material/parts
- Rotating a part to complete the operation

Identifying Waste – Excess Processing

- Waste # 8: Excess-Processing
  - Effort that adds no value to the product or service

Examples:

- Placing items in a bin and labeling them to go on a shelf to wait for the next operation
- Double/Triple checking
- Obsolete, duplicate, unnecessary process steps



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For recording process observations

Lean Process Questions

- For each step in the process ask:
  - Is this step adding value to the process?
  - Does each employee complete this step in the same manner EVERY time?
  - Are the supplies needed for step available EVERY time within 30 seconds?
  - Is the information necessary for this step readily available and correct EVERY time?
  - Does this step of the process travel as a single, simple and direct flow path to the next step?

Additional thoughts on Waste

- Focus is not only on the product or service, but also the process.
- Lean is NOT mean.
- Take a “Fresh Eyes” approach, with the Why Question.
  - *What are some examples of waste from your experience?*

Question

The customer does not pay for waste, only value-added.

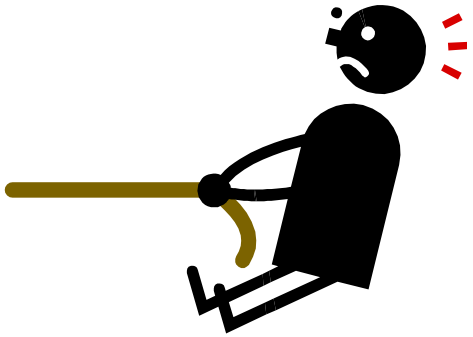
Lean Process Steps 3 & 4 – Establishing Flow and Pull

Lean Principle # 3: Establish Flow

- Make the product or service flow continuously through the steps
- Only after specifying value and mapping the value stream can lean thinkers implement the third principle of making the remaining, value-creating steps flow
- This is a paradigm shift in thinking

Lean Principle # 4: Create Customer Pull

- Introduce pull between all steps where continuous flow is possible
- Let the customer pull the product or service from you as needed rather than pushing, often unwanted, products and services on the customer



Using the Value Stream Map to Identify Areas with Potential Flow Issues

- Identify:
  - Process bottlenecks
  - High inventory between steps
  - Long cycle times
  - Long change-over times
  - Low uptime
  - High defect rates
  - Manual work within an automated system
  - Etc.

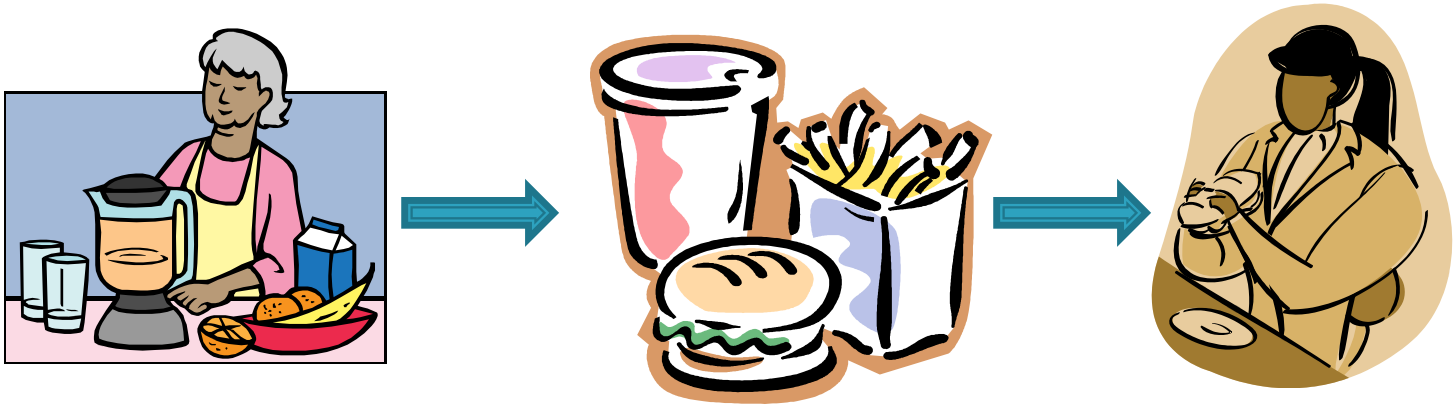
Data and visual observations of the Value Stream Map can yield issues affecting smooth process flow

Some Tools for Affecting Flow

- Take One / Make One
- Work Cells / Modules – designing a work cell to facilitate effective and efficient flow
- 5S
- Preventing Blockages
  - Source inspection – inspection during the process to eliminate “after process” inspection
  - Maintaining equipment – keeping equipment in good running order to eliminate unplanned shutdowns
  - Poka-yoke
  - SMED

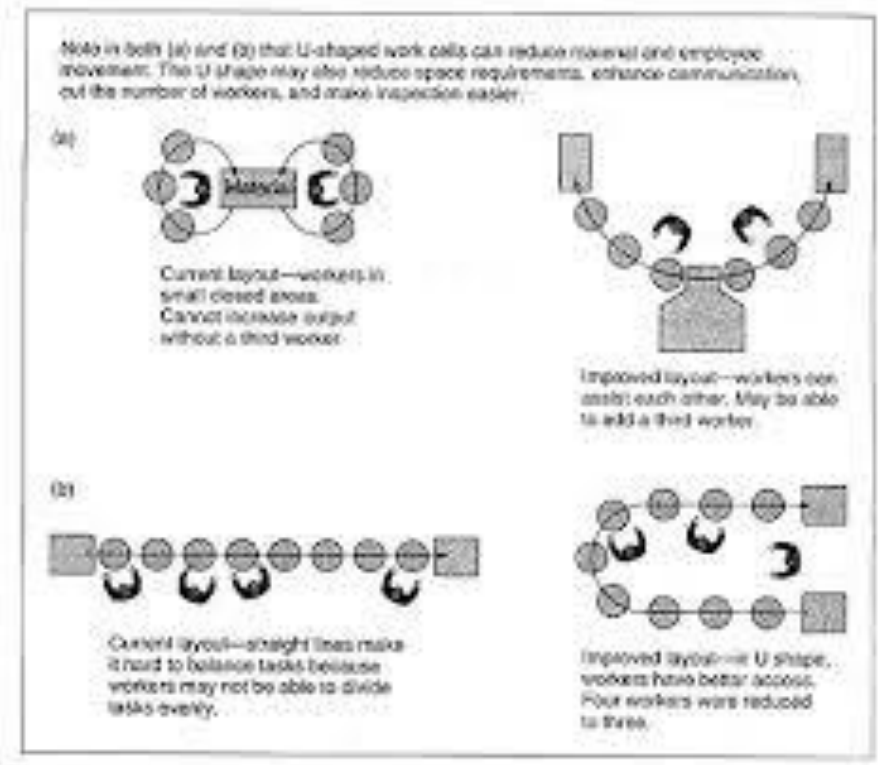
Take One / Make One

- The ideal state is one of continuous flow where the system is calibrated to customer demand
  - As you take one out of a step it triggers you to make another one to replace it
- You may never get there but that is the goal



Work Cells

- Can be designed to allow minimum wasted time and effort
- Work can be shared by operators to level the load (most commonly in a "U" shaped cell)



A Key to Lean – 5S

- Sort
- Set in Order
- Shine
- Standardize
- Sustain

5S Steps in Detail (Steps 1 and 2)

- Sort
  - Divide the items into 3 categories
    - Retain – items essential to the process function
    - Return – items belonging to another group
    - Rid – get rid of all the other things
- Set in Order
  - Find a place for everything and everything in its place
  - Establish standard locations for items
  - Move items used frequently in a convenient location

5S Steps in Detail (Steps 3, 4, 5)

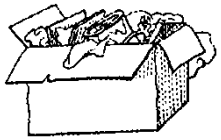
- Shine
  - Clean the entire area
  - Paint items to make them look new
- Standardize
  - Establish schedules and systems to maintain your changes
  - Example: shadow boards for tools
- Sustain
  - The most difficult step – keep the area in its new state

5S: Workplace Organization

Before 5S

S1: Sort
(Seiri)

Not Needed

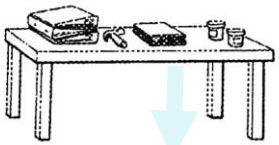


(Red Tagged)

Remove from Workplace

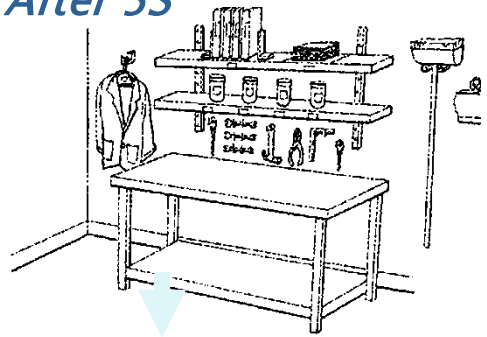
Discard after a defined time

Needed



Create Visual Workplace
- S2: Set In Order (Seiton)
- S3: Shine (Seiso)
- S4: Simplify & standardize (Sieketsu)

After 5S



- S5: Sustain (Shitsuke)

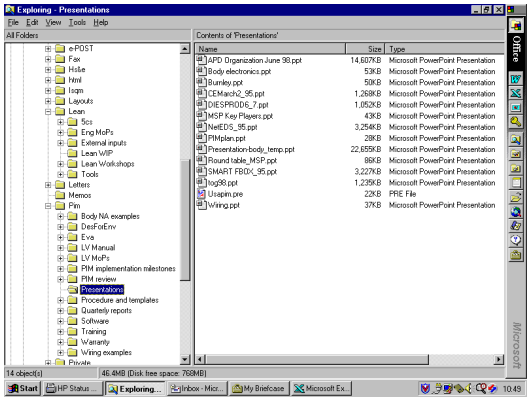
A place for everything and everything in its place

5S: Work Organization and Configuration

The physical and electronic workplaces

Lack of standards and discipline for organization and configuration

- *loss or damage to documents/files*
- *use of wrong versions*
- *equipment not maintained*
- *searching*



5S Example

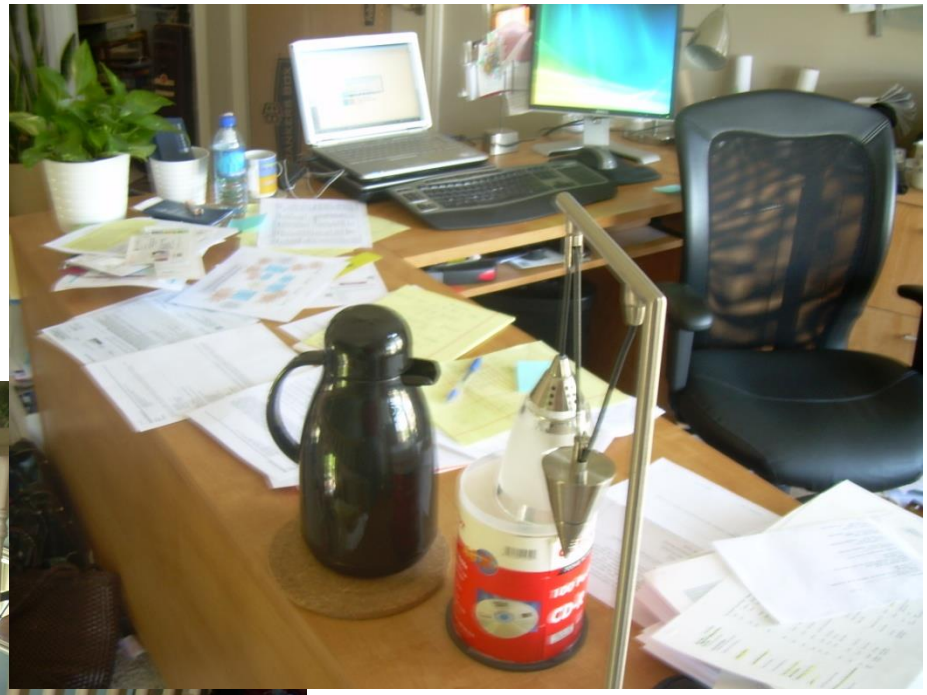
Prior to a 5S workshop, supplies were stored on the floor and countertops, as shown

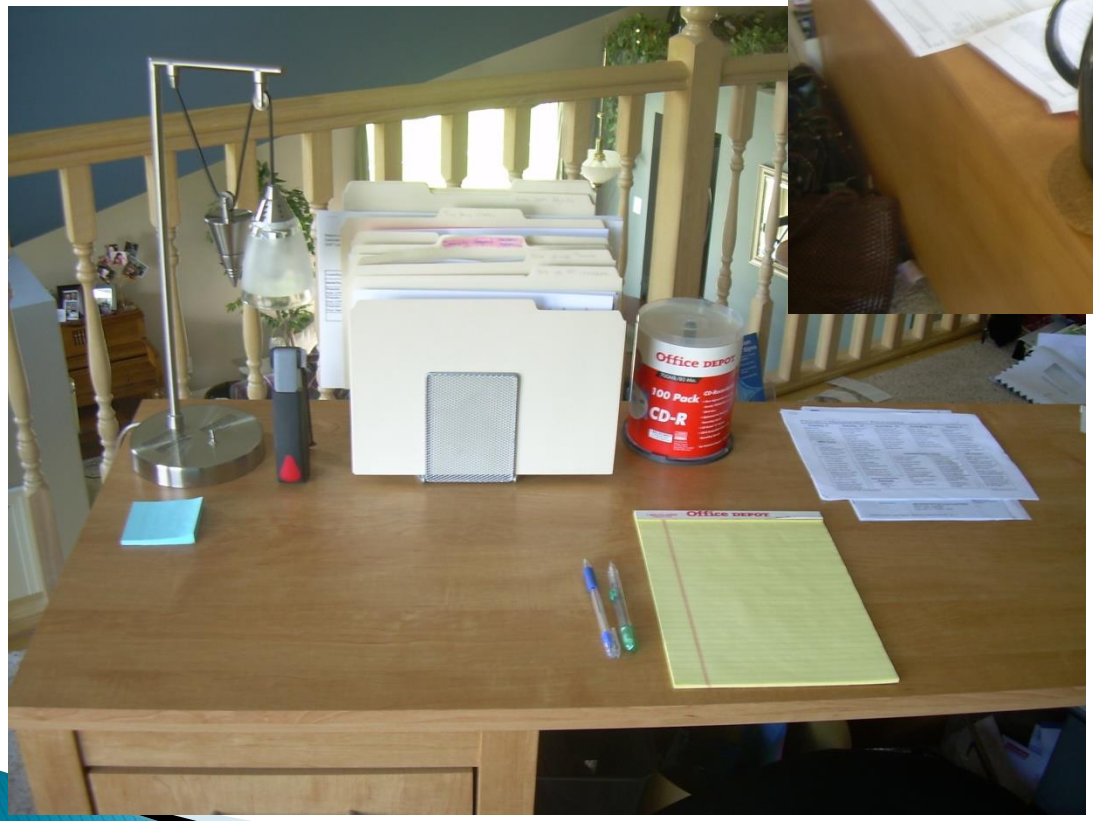
5S: Work Organization and Configuration

Afterwards, countertops are clear; drawers and cabinets are labeled with their contents, as shown in the two bottom photos.
Over-stocking and stock-outs were virtually eliminated.

5S Examples

Before 5S





After 5S

A 5S Method

Areas are delineated for certain items in the office or on the shop floor to keep the items from "spreading" into chaos

Visual Controls

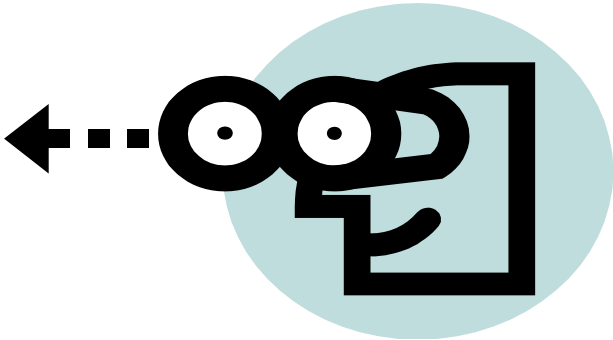
- Key principle: make it visible
  - Everyone, including outsiders, can see and understand the status of the process at all times
  - See
    - Flow
    - Performance
    - Problems
    - Opportunities for improvement

- Visual controls include:
  - Process measurement displays
  - “Andon” Boards which display a signal to alert people of an issue at a particular location

Visual Workplace Rules

- Tools, supplies, and equipment must be
  - Easy to see
  - Easy to use
  - Easy to return

- 30-second rule
  - Items accessed at least once a month should be located within 30-seconds
    - Supplies
    - Tools, equipment
    - Information



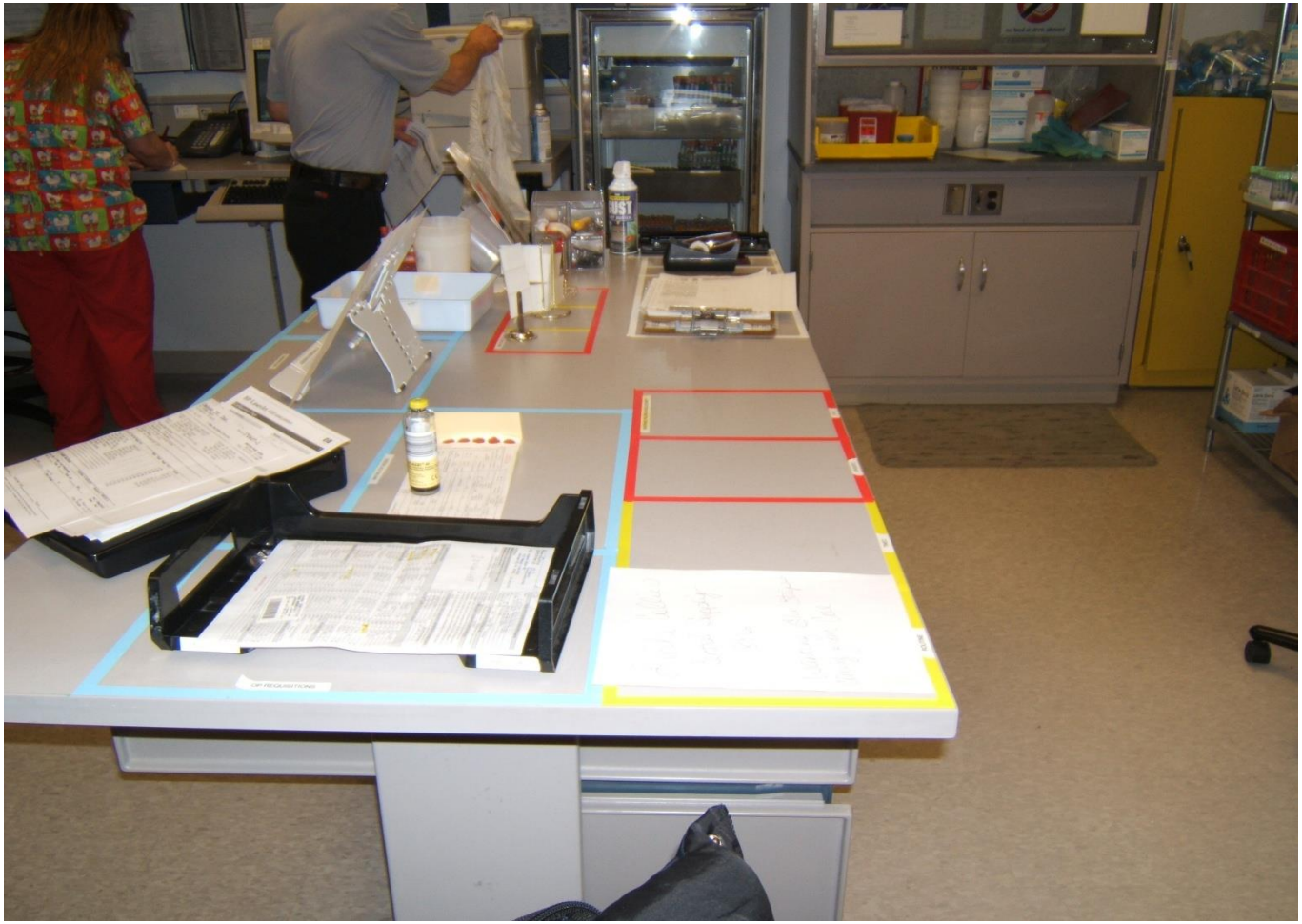
Visual Controls

Before & After Pictures

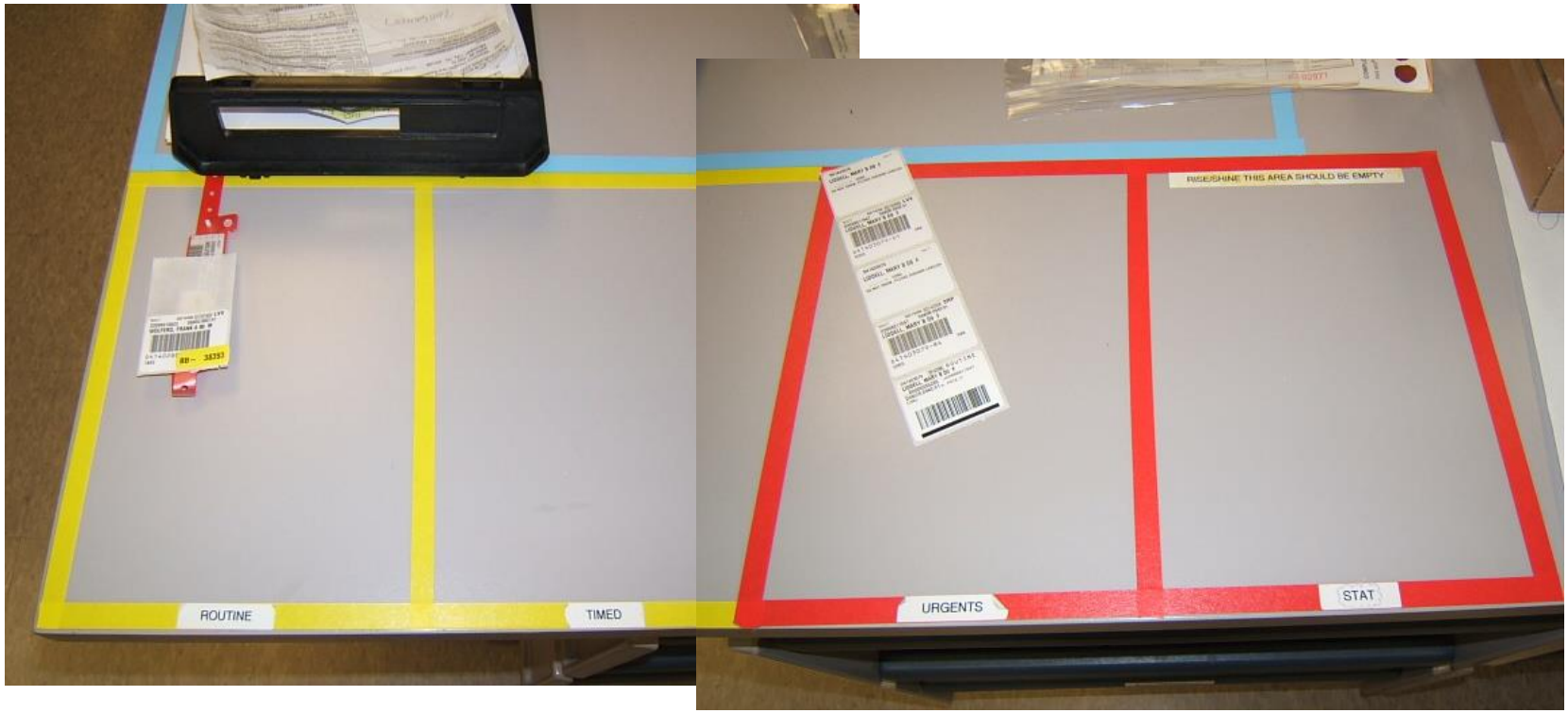
What more could be done?

Visual Controls

Visual Controls + 5S



Visual Control Examples



Sorting by Urgency

Source Inspection
Built-In-Quality

- Work is reviewed BEFORE it is passed on to the next step
- Review time is identified as part of the standard work for the organization
- Do It Right the First Time!

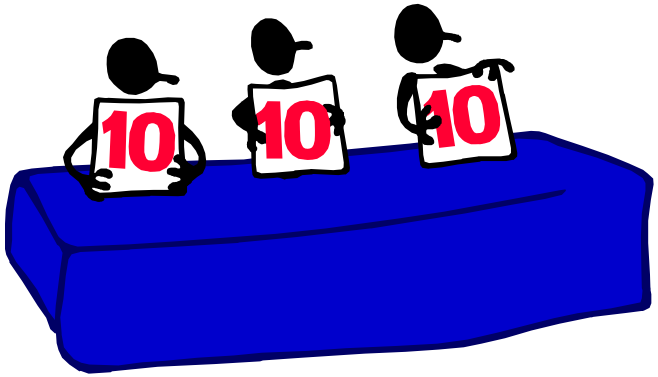
- BENEFIT
  - Any problem is identified and corrected/contained before it gets to the next step
  - This eliminates complex rework processes

Maintaining the Equipment

- Also called TPM (Total Productive Maintenance)
- There are three main areas:
  - The operators perform their own routine maintenance
  - Planned maintenance (on a schedule)
  - Predictive maintenance
    - Using data to anticipate failures
    - Allows you to keep spares on hand based on the maintenance schedule and emergency needs

Poka-Yoke & Boka-Yoke

- Error proofing (poka-yoke)
  - Any task that requires human intervention and judgment to prevent mistakes is a mistake waiting to happen
- Error prevention (boka-yoke)
  - Preventing errors from reaching the customers



Poka-Yoke & Boka-Yoke Examples

- What items in your car are Poka-Yoke?

Examples:

-Assembly keys, gages

-Medical gas connectors can not fit other medical air connections

-Other examples?

Poka-Yoke Examples

- Visual Clues does not mean Poka-Yoke !

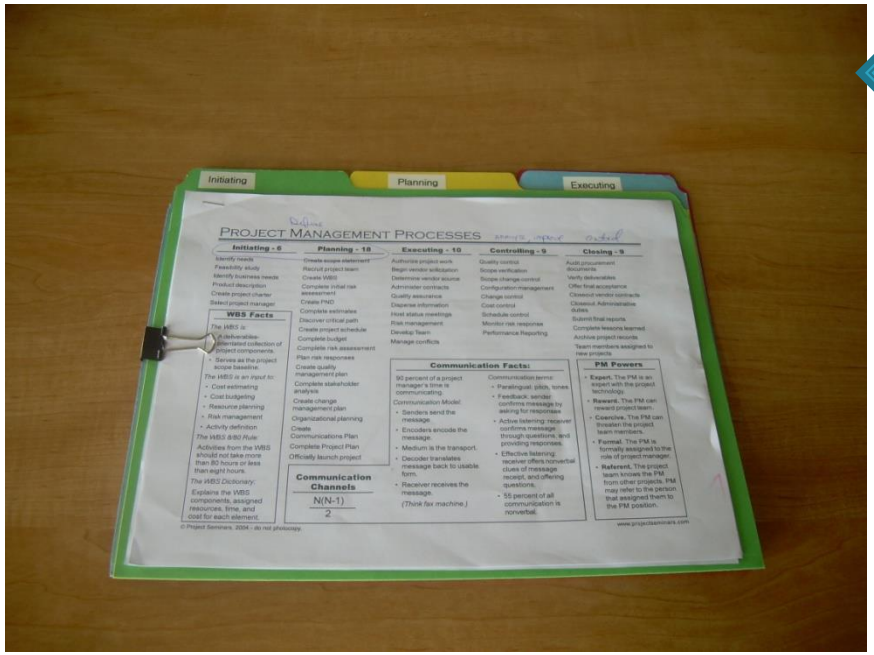
Example:

1. Color coding on video connections
2. A file cabinet warning

Setup Reduction

- Setup Reduction
  - Also known as SMED (Single Minute Exchange of Die)
  - Reduction and elimination of setup time associated each process
  - Strive for performance of as much setup work as possible prior to processing step
  - Allows conversion from batch and queue to small lot operations

Setup Reduction Examples



An assembled packet of forms and folders used on a project

A process mapping kit which contains all the needed shapes and instructions

Before SMED

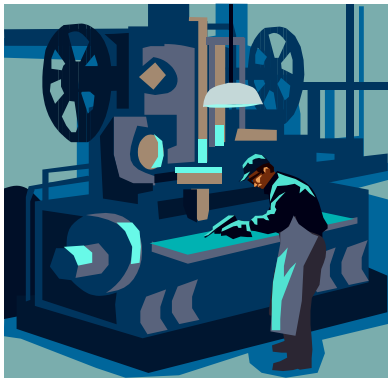
Typical changeover: 1 – 2 hours

A lot of wasted effort and tool usage!

After SMED

Typical changeover: 15 seconds

Real World Examples



- 3000-ton sheet metal stamping press
  - Before: 4 hours
  - After: 3 minutes
  - Improvement: 98.7%, or a factor of 80
  - Now the same press can make multiple parts (hoods and doors in this case) for the Camry, only what is needed for the next hour of production.

- 400-ton LIM molding press with 16-cavity tool
  - Before: 3 hours
  - After: 18 minutes
  - Increase in effective capacity equal to 5,184 additional parts

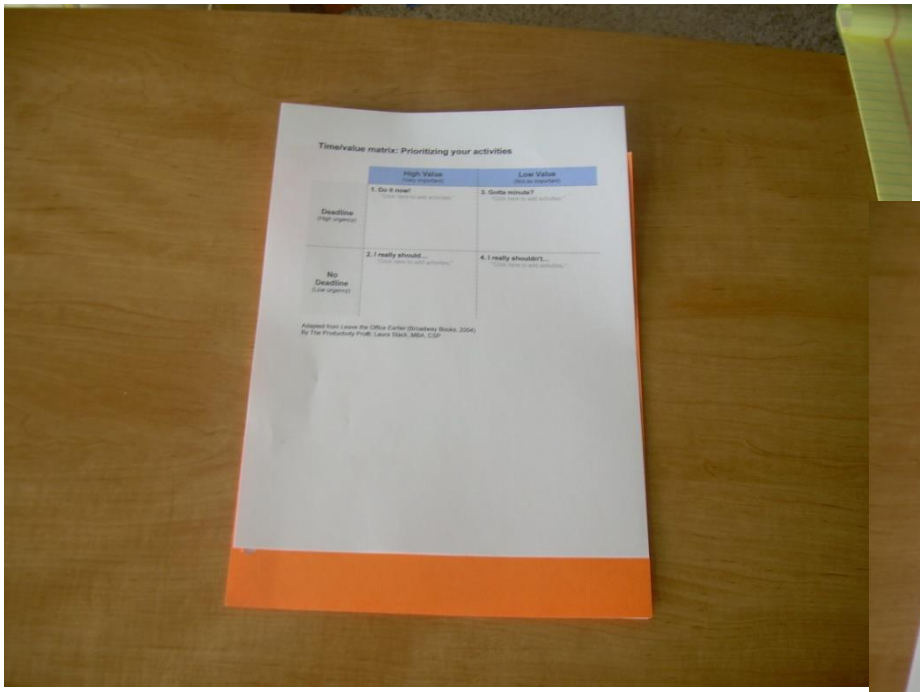
A Tool for Affecting Pull

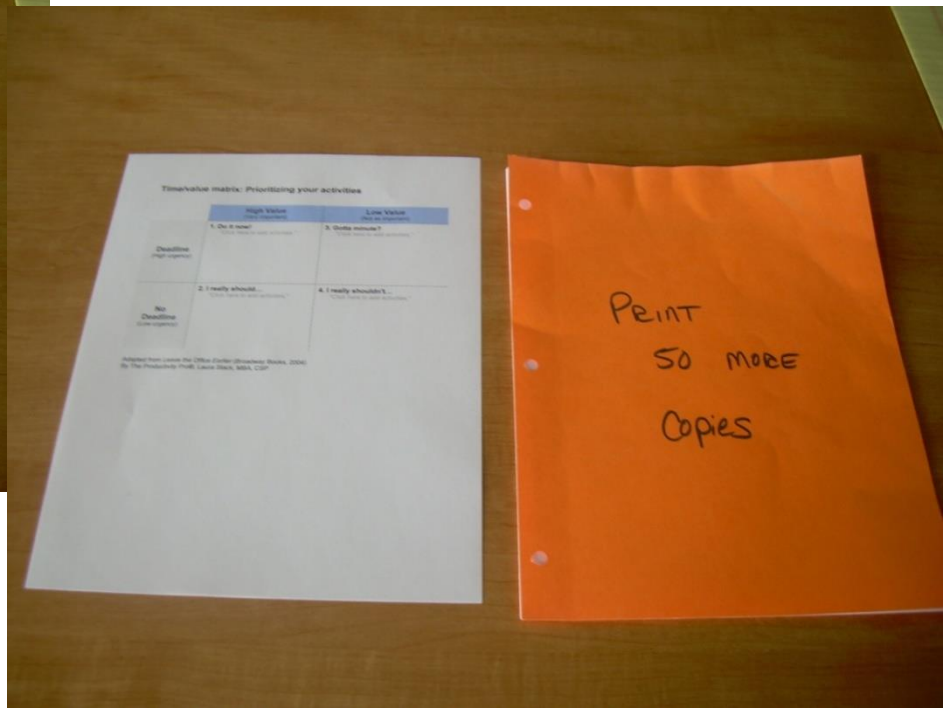
- Kanban or Replenishment

- Kanban is a signal that triggers replenishment in a pull system; the signal regulates the production flow in the system
- Kanban comes in many forms…
  - A card
  - An empty container
  - An empty space that needs filling

Kanban Example

Kanban means signal – a replenishment alert!

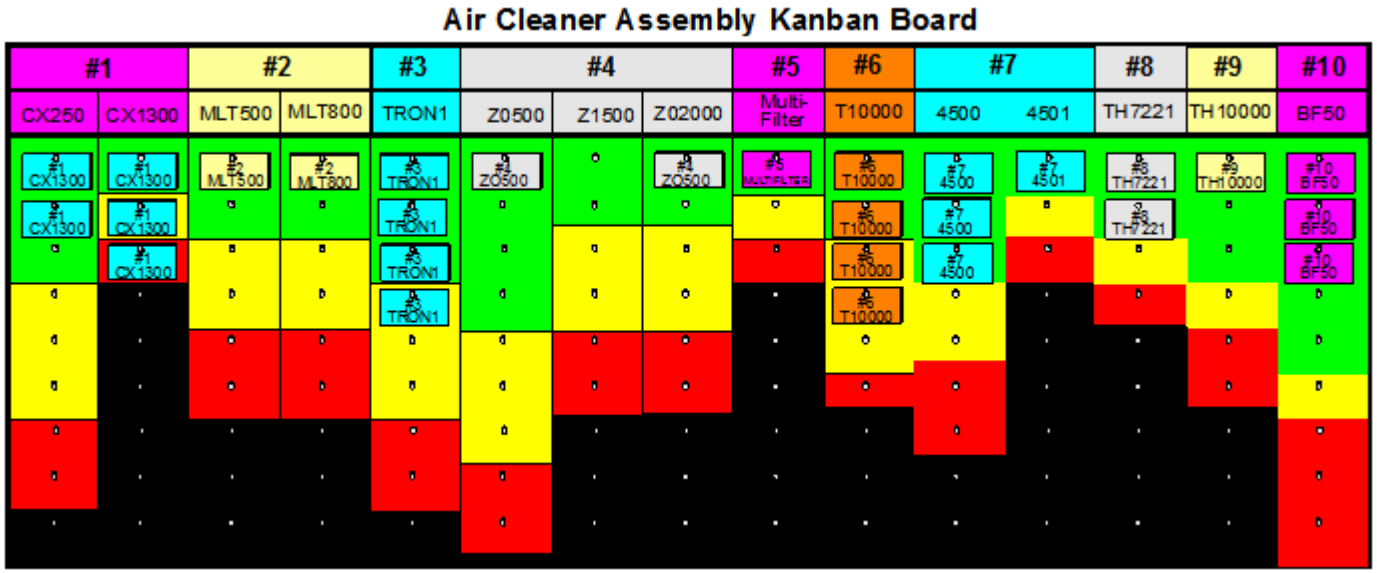




Kanban example:

Kanban Board

- This board shows the material replenishment team the number of each item that is left in the supply of a work cell
- As items are used, their card is placed on the board (starting with the Green area); as the supply is replenished, the cards are removed
- If the cards reach into the yellow and red area it means the need is critical
- The number of card spaces for each item is the number of items kept along with the number of “safety” items kept on the process supply



Lean Process Step 5 – Pursue Perfection

Lean Principle # 5: Pursue Perfection

- Manage toward perfection so that the number of steps and the amount of time and information needed to serve the customer continually falls
- There is no end to reducing the effort, time, space, cost, and mistakes while providing a product or service the customer thinks they want

Perfection Tools Include:

- Standardized Work
- Improving with Kaizen
- Visual Management Tools
  - Andon
  - The Seven Basic Tools
  - Display Boards
  - 5 Whys

Standardized Work

- Begin with the work task required by your customer demand
  - Add:
    - Specification Standards – quality, methods and tools
    - Subject Standards – company rules and policies, regulatory and compliance standards
    - Technical Standards – materials, components, products and services
- 5 Rules
  1. Help people be more safe and effective in what they do
  2. Standardize repetitive work
  3. Keep the equipment in condition
  4. Make standardization sheets accessible
  5. Review and revise the worksheets regularly

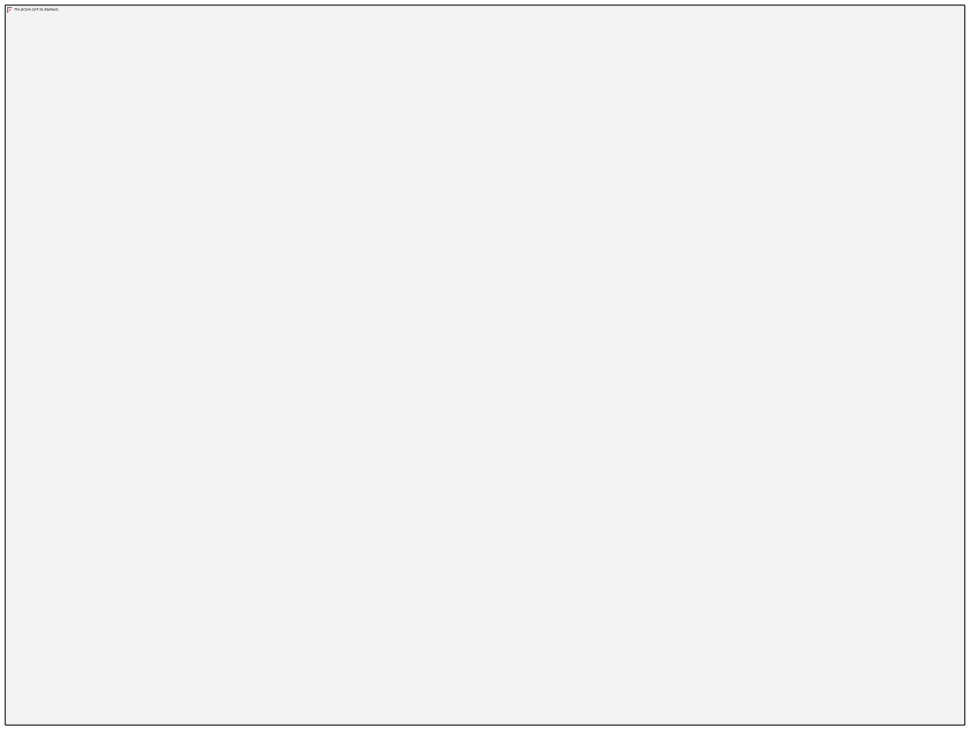
What is Kaizen?

- 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

Deming Cycle



Kaizen Blitz

- Rapid Cycle Process Improvement
  - Identifies and analyzes a process
  - Develops a plan for improvement
  - Develops a plan for evaluation and continued monitoring
- This methods occurs through:
  - Rapid or short-term work of a multidisciplinary team, usually 3-5 days
  - Follows a period of preparation work

Kaizen Blitz – con't

- Typically occurs in the Measure phase of the Kaizen/DMAIC process as additional data is being gathered for measurement and statistical analysis
  - Are often identified during the Process Observation and Waste Walk

Typical Kaizen Agenda (5 Day Event)

- Pre-Event – Value Stream the Process
- Day 1 – Train the Kaizen Area
  - Lean Concepts and Principles
  - Types of Waste
  - Review the Value Stream Map for the process
    - Determine individual process steps for main steps in the VSM
  - Train on data gathering tools
  - Understand the area metrics
- Day 2 – Current State Analysis
  - Analyze Current Process and Label Waste
  - Brainstorm improvements
  - Design new work processes

Typical Kaizen Agenda (5 Day Event)

- Day 3 – Implement the New Process
  - 5S
  - Establish one-piece flow
  - Implement the changes
  - Develop instructions
  - Pilot changes
- Day 4 – Observe the Process and Refine
  - Verify using data
  - Establish standard work for the new process
- Day 5 – Sustain and Celebrate
  - Establish visual controls
  - Establish follow-up plan
  - Present the results and celebrate

The 7 Basic Tools and 5 Whys

- Many of these were covered in the Six Sigma modules
  - Ishikawa (fishbone) Diagrams
  - Pareto Charts
  - Check Sheets
  - Scatter Plots
  - Bar Charts
  - Histograms
  - Control Charts

  - 5 Whys

Display Boards

- Display boards communicate information about the process
  - Key Customer measures
  - Process Performance
  - Improvements
  - Communication

Theory of Constraints – A Close Cousin to Lean

Theory of Constraints

- The Theory of Constraints (TOC) was developed by Eli Goldratt to describe the impact of process constraints on flow through a system or process
- The TOC states that process and system throughput cannot be increased unless the throughput is increased at the bottleneck in the system

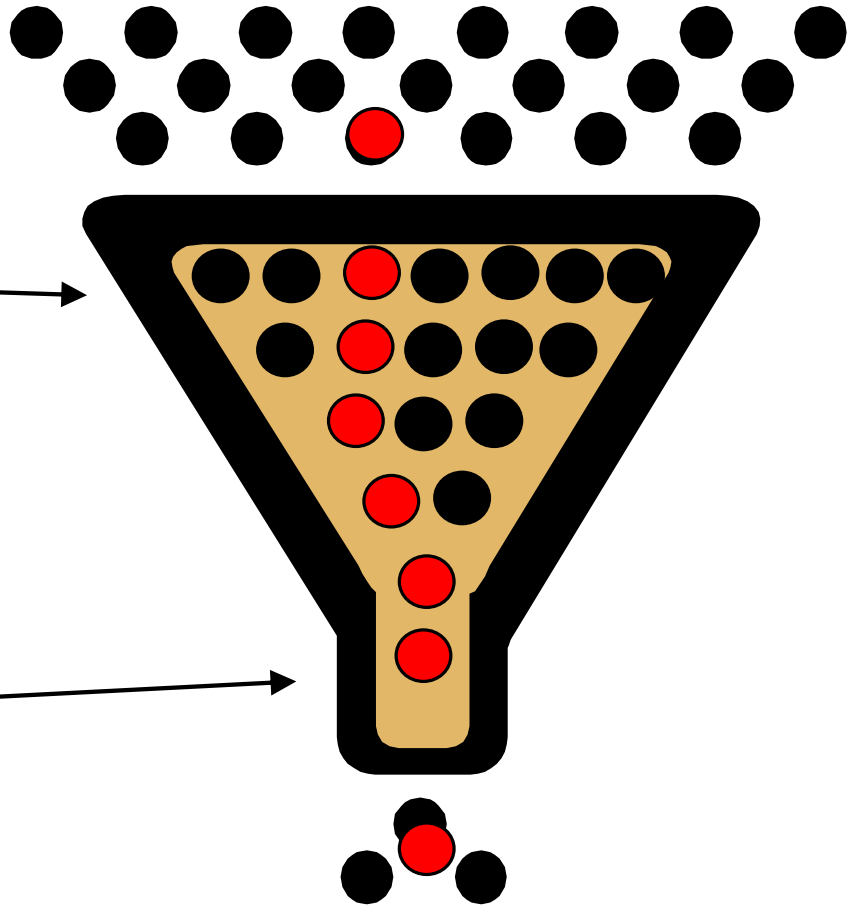
Theory of Constraints Definitions

- Flow: The rate at which a process inputs (paperwork, materials, and information) are able to progress through the processes
- Constraint: Any process step that limits the overall process flow
  - Missing or incomplete information
  - Materials or supplies
  - Limited staffing capacity

Constraints are also referred to as bottlenecks.

The Theory of Constraints (TOC)

Flow: The rate that items move through the 'process'



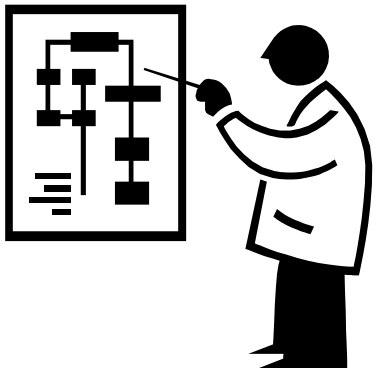
The neck of the funnel is the *Constraint* or Bottleneck.

Theory Of Constraints

Five Steps to Focus Improvement at a Constraint

1. Identify the constraint
   - Physical constraints
   - Policy constraints

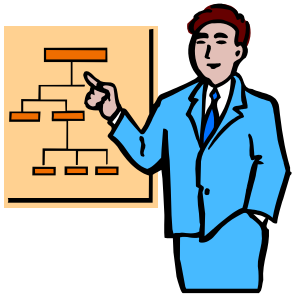
2. Decide how to exploit the constraint
   - How will the constraint be eliminated or managed?



Theory Of Constraints

Five Steps to Focus Improvement at a Constraint

3. Subordinate everything else in the process to
   the constraint
   - Adjust the rest of the system to enable the constraint to operate effectively
   - Elevate the constraint
4. Invest time, energy, and money to eliminate
   the constraint
5. Go back to Step 1, but beware of inertia

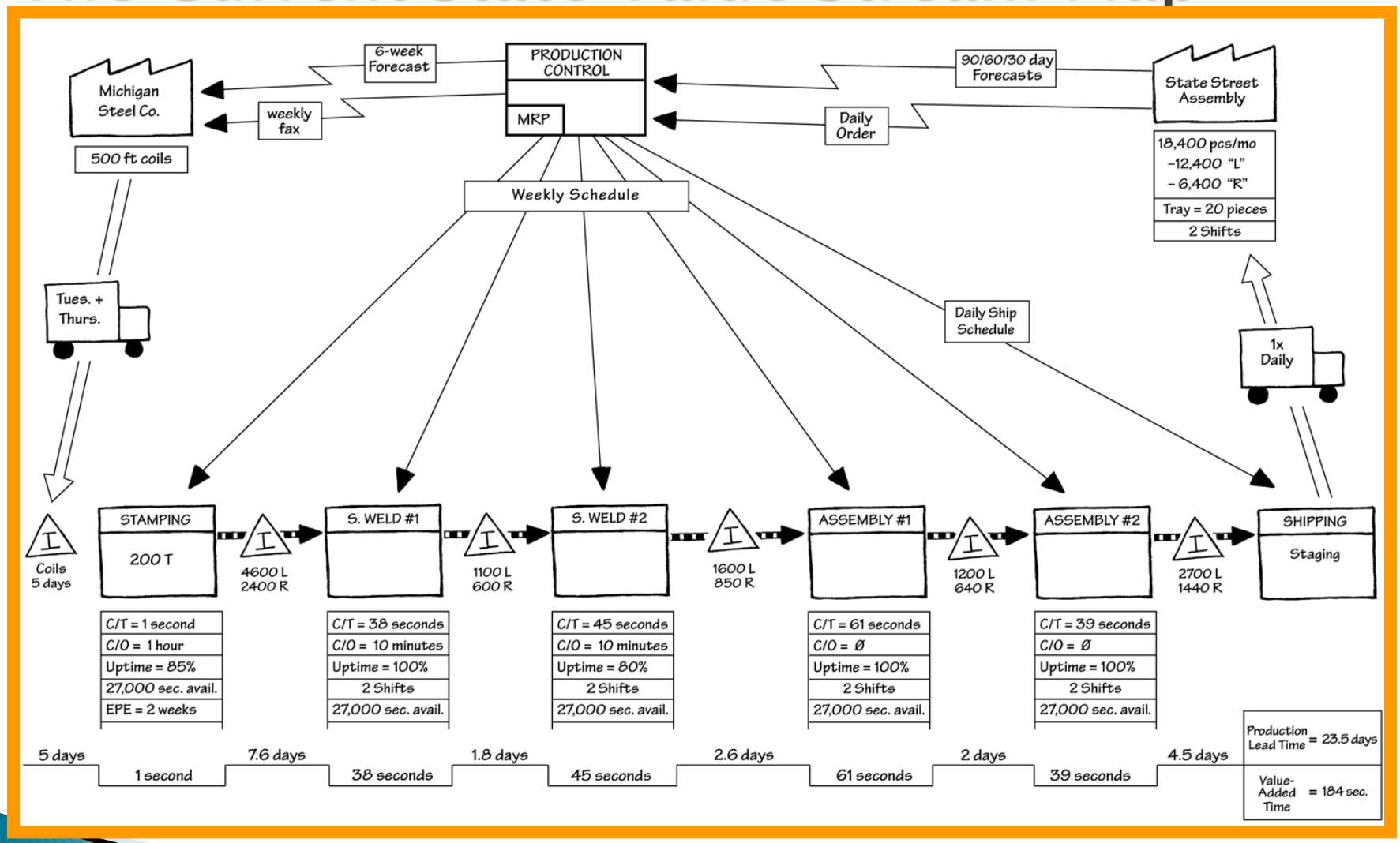


The Results of Continuous Improvement

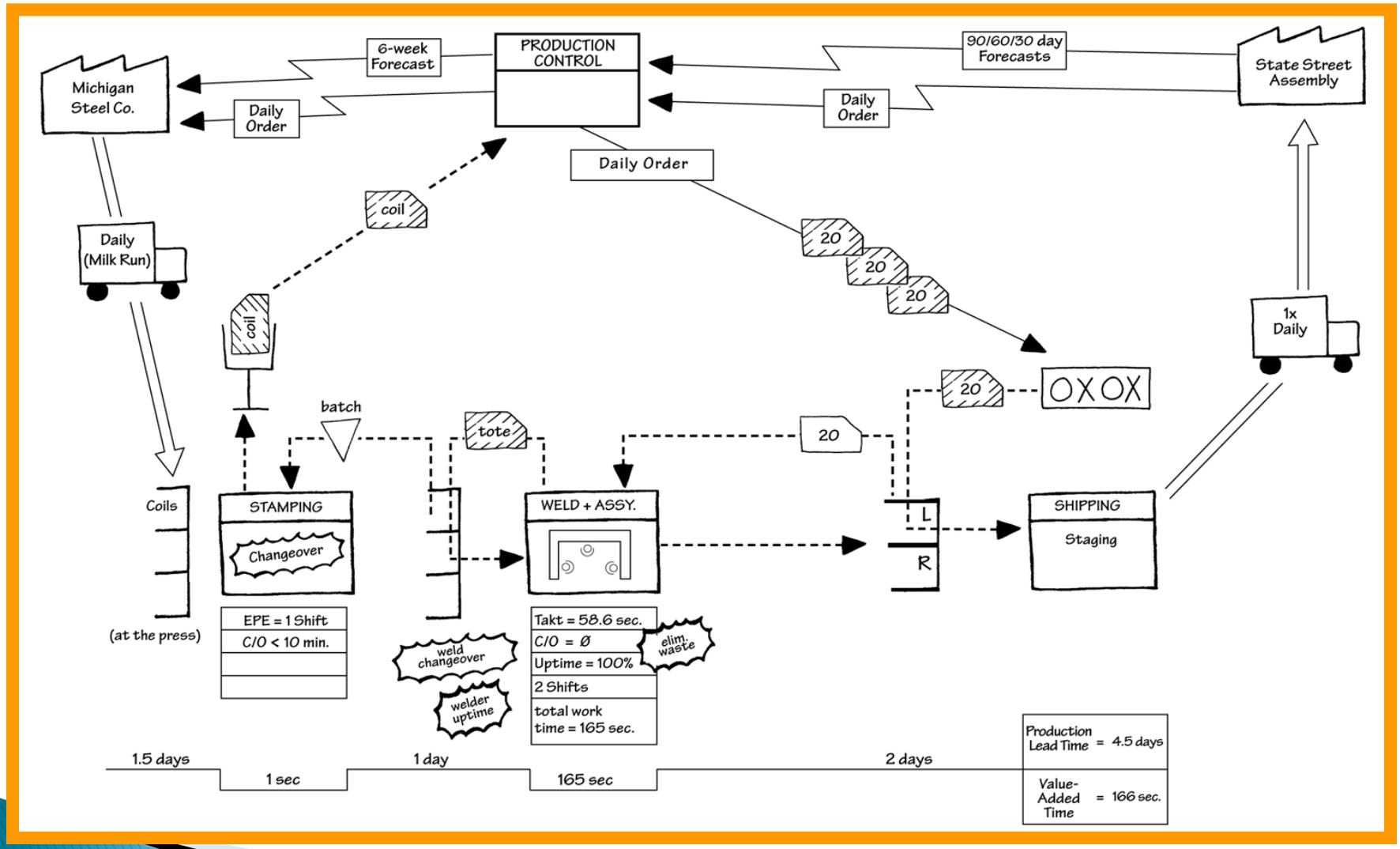
Going from the Current to the Future State

- The objective of Lean is to transform the process of an inefficient state to a more efficient state
- Improvement will be related to the Pareto Principle – big gains can be made at first but future efforts will come more slowly

The Current State Value Stream Map



The Future State



Class Exercise

- Create Basic Current and Future State Value Maps for the Class Scenario
  - Determine the most likely areas where Kaizen bursts could be carried out
  - List the more detailed steps for each macro step under that step
  - Label each detail step as VA, NVA, BVA
  - Determine and document the ideas for eliminating NVA steps using the tools of lean

Questions?