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Lean Manufacturing and Six Sigma

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Research Questions

- What have we done in the past?
- What must we do in the future?
- How do we know these are the correct actions?

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Lean Definitions

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Key concepts of lean:

- The cost reduction principle (Value Engineering)
- The seven deadly wastes
- The 5S System
- Visual Workplace (CROPIS)
- Three stages of lean application (demand, flow, and leveling)
- Two pillars of TPS (JIT production, and Jidoka)

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Cycle Time

- Cycle time is the time that elapses from the beginning of an operation until its completion- in other words, it is the processing time
- Don't confuse this measure of processing time with takt time, which is the measure of customer demand

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The seven deadly wastes:

- Waste of overproducing
- Waste of waiting
- Waste of transport
- Waste of processing
- Waste of inventory
- Waste of motion
- Waste of defects and spoilage


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Two pillars support the Toyota Production System:

- JIT production – the ideal state of continuous flow characterized by the ability to replenish a single part that has been “pulled” by the customer.
- Jidoka – the practical use of automation to mistake-proof the detection of defects and free up workers to perform multiple tasks within work cells.

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JIT (Continuous Flow Production):

- Only those units ordered
- Just when they are needed;
and
- In the exact amount needed

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The Three Functions of Jidoka:

- Separate human work from machine work.
- Develop defect-prevention devices.
- Apply jidoka to assembly operations

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By implementing 5S, you will:

- Teach everyone the basic principles of improvement.
- Provide a starting place for eliminating all waste.
- Remove many obstacles to improvement (with very little cost).
- Give workers control over their workplace.

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The 5S system consists of five activities:

Sort – sorting through the contents of an area and removing unnecessary items.

Set in Order – arranging necessary items for easy and efficient access, and keeping them that way.

Shine – cleaning everything, keeping it clean, and using cleaning as a way to ensure that your area and equipment is maintained as it should be.

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- **Standardize** – creating guidelines for keeping the area organized, orderly, and clean, and making the standards visual and obvious.
- **Sustain** – educating and communicating to ensure that everyone follows the 5S standards.

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Positive impacts of the 5S system

- Reduced total lead time
- Elimination of accidents
- Shorter changeover times
- Improved worker attendance
- Value-added activities
- More improvement ideas per worker

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Three stages of lean application

- Customer demand stage
- Flow stage
- Leveling stage

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Common principles

- **Stabilize (Define)** your processes, reviewing customer demand, equipment capabilities, labor balance, and material flow.
- **Standardize (Control)** your processes and the work.
- **Simplify (Shift the Mean)** through kaizen, *after* you have stabilized and standardized processes.

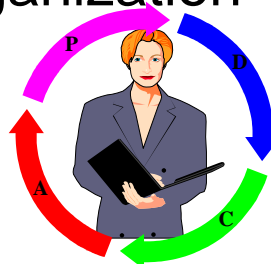
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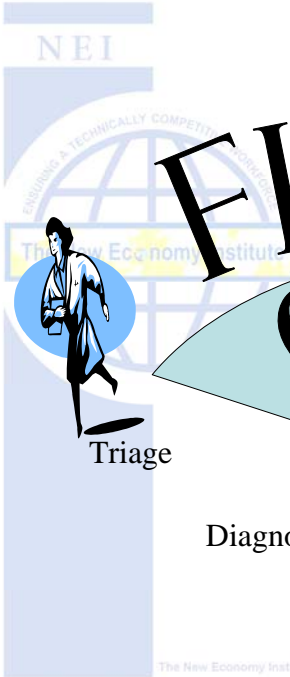
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The FIT Organization




Triage – Define and Measure
Diagnoses- Analyze
Prescription- Implement
Scheduled Checkups- Sustain


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FITORG CROPIS




Triage



Diagnoses




Prescription



Scheduled Checkup


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TRIAGE Implementation


The sorting and allocation of projects according to a system of priorities designed to maximize total customer satisfaction.

- Roadblock Identification and Rapid Removal
- Philosophy, Infrastructure, Tools and Techniques
- Strategic Plan outlining business initiatives
- CROPIS integrating voice of the customer
- Prioritized list of projects & selected team members
- Team Charter providing non-restrictive direction



Triage

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TRIAGE: Philosophy

"All Models are wrong but some are quite useful!"

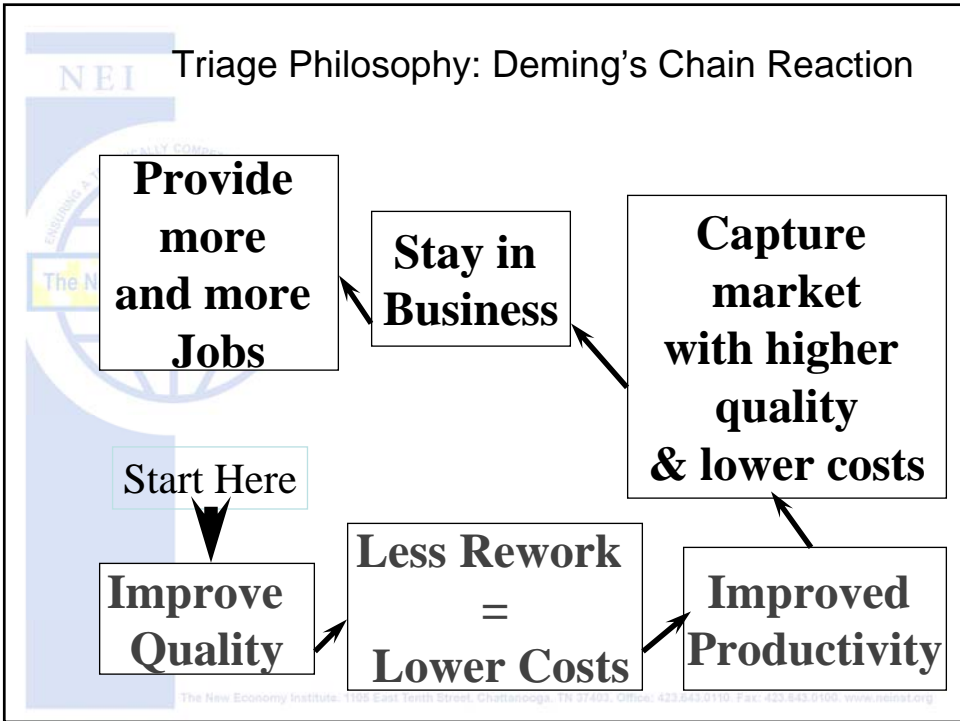
Quality


- Shewhart Cycle: Plan Do Check Act
- Deming's Chain Reaction
- Gavin Quality Definitions

Performance

- Taylor Scientific Management
- Gilbreth Methods Engineering

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Triage Philosophy: Gavin's Quality Definition

- Transcendent Based
- Product Based
- User Based
- Manufacturing Based
- Value Based

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Quality is Defined by the Customer

CROPIS according to Gavin

Customer -- Requirements -- Output -- Process -- Input -- Supplier

← **Value Based** →

← **Manufacturing Based** →

← **User Based** →

← **Product Based** →

← **Transcendent** →

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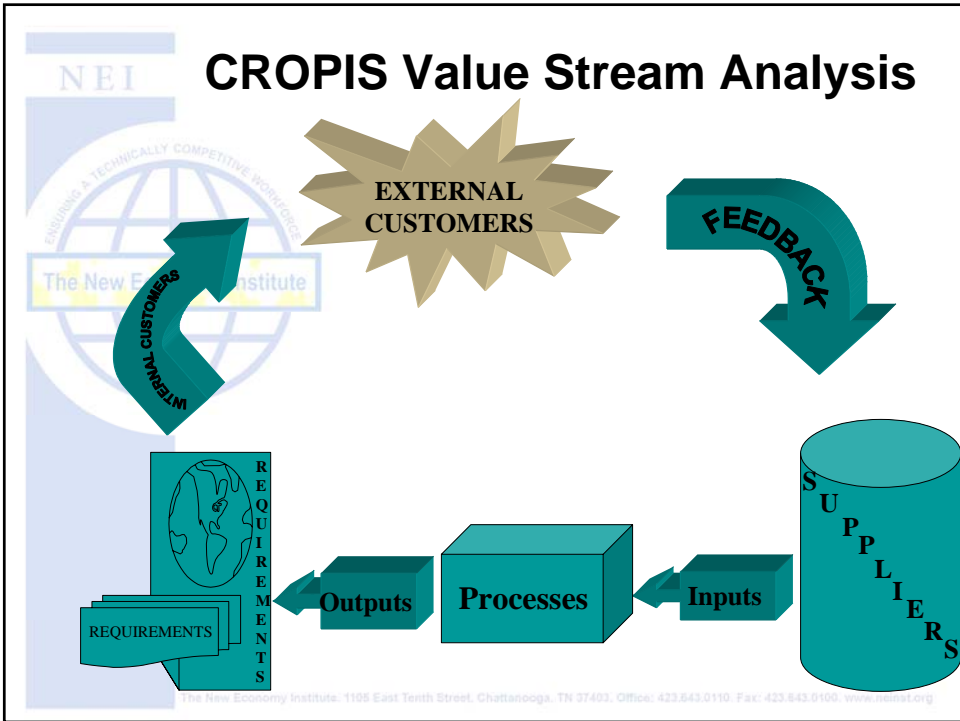
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TRIAGE: Infrastructure

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- Lean Manufacturing
- Total Quality Management
- Zero based Budgeting
- Quality Circles
- CROPIS Analysis Engineering
- Six Sigma
- Business Process Re-engineering
- Statistical Process Control
- Employee Empowerment
- Methods and Standards

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A CROPIS value stream consists of :

- Communication all along the supply chain regarding orders and order forecasts.
- Material transport and conveyance.
- Production planning and scheduling.
- The network of processes and operations through which *material and information flows in time and space* as it is being transformed.

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Selecting value streams for improvement:

- **Product-quantity (PQ) analysis:** Start with PQ analysis first to see if some part numbers are run in volumes high enough to make the choice an obvious one.
- **Product-routing analysis.** Use product-routing analysis if results from PQ analysis are inconclusive.

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To perform PQ analysis, follow these steps:

- Obtain three to six months' worth of data on production output.
- Enter your products by quantity (from greatest to least) on a PQ analysis list
- Create a Pareto chart using the data from the PQ analysis sheet.
- Analyze the product mix.

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Using Product-Routing Analysis

- Start by showing the process sequence-the sequence of operations-for each product type listed by volume.
- Next, group together the products that have the same process routes.
- Analyze the mix of process routes.

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A few rules of thumb for additional considerations for value stream selection

- Choose a value stream that includes no more than one machining operation.
- Choose a value stream that includes no more than three raw material suppliers.
- Choose a value stream that includes no more than twelve operations or process stations.

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Ways to determine the scope of a value stream map via CROPIS

You can define activities and measure the time it takes to go from conceiving a product to launching it

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Ways to determine the scope of a value stream map via CROPIS

You can define the activities and measure the time it takes from receiving raw materials to shipping finished parts to a customer

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Ways to determine the scope of a value stream map via CROPIS

You can define the activities that take place from the time an order is placed until cash is received for the finished order

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CROPIS Analysis will allow you to:

- Visualize the entire manufacturing material and information flow, instead of a single, isolated operation
- Visualize how operations currently communicate with production control and with each other
- See problem areas and sources of waste

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CROPIS Analysis

- Locate bottlenecks and WIP
- Spot potential safety and equipment concerns
- Provide a common language for all manufacturing personnel
- Gain insight into how the operation truly is running that day

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CROPIS Analysis for mapping the current state:

1. Working in a conference room as a team, draw rough sketches of the main production operations on a white board.
2. Go to the floor, beginning with the most downstream operation, and collect actual process data.
3. Regroup away from the floor to discuss the results of the data gathering efforts and make sure that all necessary data has been collected.

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Basic CROPIS metrics that companies find useful:

- Inventory turns
- Days of inventory on-hand
- Defective parts per million (DPPM) or sigma level
- Total value stream WIP
- Total cycle time, or total value adding time
- Total lead time

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- Uptime
- On-time delivery
- Overall equipment effectiveness
- First-time- through capability
- Health and safety record (including OSHA recordable and reportable incidents)

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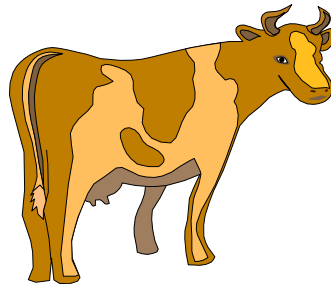
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Lean Manufacturing and Six Sigma: TRIAGE Infrastructure Example

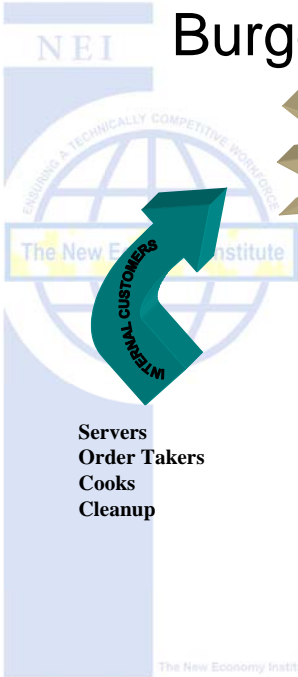
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Burger Doodle Infrastructure



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Burger Doodle Customers

EXTERNAL CUSTOMERS

INTERNAL CUSTOMERS


Young Families

Teenagers

Empty Nesters

Servers
Order Takers
Cooks
Cleanup

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Burger Doodle Requirements

- **Food**
- **Speed**
- **Economy**
- **Social Opportunities**
- **Consistency**
- **Cleanliness**
- **Physical**

REQUIREMENTS

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- Burgers
- Shakes
- Fries
- Restrooms
- Playrooms
- Dining Facility
- Parking
- Drive Through

← Outputs

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Burger Doodle Processes

1. Training
2. Order Taking
3. Cooking
4. Order Delivery
5. Cleaning

Processes

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Burger Doodle Inputs

Food

Marketing Data

Supplies



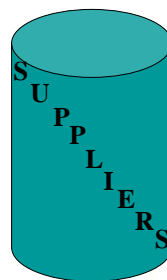
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Burger Doodle Suppliers

Food Suppliers

Franchiser




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System Infrastructure

- **Strategic Planning & Implementation**
 - What actions are needed?
 - In what order should they be addressed?

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System Infrastructure

- **Tactical Planning & Implementation**
 - Who should do them?
 - What resources are required?

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System Infrastructure



- Action Planning & Implementation
 - What is the situation?
 - How can it be improved?
- Recycle

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Lean Manufacturing and Six Sigma:



Tools and Techniques

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Triage Tools and Techniques

Tools for the Diagnoses Phase are selected during Triage and the entire team is trained in their usage

- Statistical Process Control
- Classes of Change and Possibility Guides
- Hierarchy of Work Units
- Project Management and Gantt Charts
- Flow Diagrams
- Cause and Effect Diagrams
- Methods Engineering Tools
- Ergonomic Analysis

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Short term pains may include:

- Additional tooling/fixtures required to reduce setup times.
- Overtime to rebalance lines and educate the workforce.
- Smaller trays/carts for small-lot production.
- Initial buffer and safety inventory.
- Engaging a lean expert to accelerate your efforts.

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Short term pains cont.

- Benchmarking to “see” (or understanding) how others have achieved success.
- Managers/supervisors/team leaders spending time to thoroughly understand lean.
- Reorganization of the facility.

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You can expect to see these long-term gains:

- Work-in-process: from weeks to days.
- Defect rate: from 3 sigma to 6 sigma (from 10,000 defective ppm to 3.4 defective ppm).
- Value-added ratio: 500 percent increase.
- Changeover reduction: from hours to minutes.

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- Overall equipment effectiveness: 40 percent increase.
- Process routing: from greater than 1,000 feet to less than 20 feet.
- Factory floor space: greater than 50 percent reduction.
- People: significantly increased expression of latent creative potential.

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Other tangible benefits of becoming lean:

- Makes work safer and easier.
- Sharpens perception.
- Promotes cooperation.
- Shortens feedback loops.
- Speeds corrective action.
- Speeds learning.
- Improves process reliability.

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Steps to designing a future state with the tools:

1. Determine takt time and pitch
2. Determine whether you can meet demand using current production methods
3. Determine whether you need *buffer and safety inventories*
4. Determine whether you need a *Finished Good Supermarket*
5. Determine which improvement methods you will use

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