MONASH University

FIT2090 BUSINESS INFORMATION SYSTEMS AND PROCESSES

Lecture 6 Lean Operations and Quality

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GROUP OF EIGHT AUSTRALIA
CENGAGE Learning

Principles

- Organisations aim to be lean in their operations to improve service or achieve competitive advantage
- Lean and quality concepts can help businesses to lower costs, increase profits, improve service and achieve competitive advantage

Objectives

On completion of this lecture, you will be able to:

- Describe the Six Sigma Quality concept
- Discuss ways of implementing Six sigma quality
- Define the term “lean” and “quality”
- Describe the quality tools and their role in applying lean concepts

Why should we study/understand – Lean Operations and Quality

- Due to competition and 'globalization' successful companies cannot afford internal inefficiencies
- Customers have become more demanding
- So organizations must achieve:
  - Internal efficiency
  - External effectiveness

- To achieve internal efficiencies and external effectiveness, organisations must be lean in their operations and maintain quality in their products/services

Process Improvement: Six Sigma Quality Programs

- Six Sigma is originally a company wide initiative at Motorola for breakthrough improvement in quality and productivity
  – Launched in 1987
  – Motorola the received the US National Quality Award 1988
- The ongoing success of Six Sigma programs has attracted a growing number of prestigious firms to adopt the approach
  – Ex. Ford, GE, AMEX, Honeywell, Nokia, Phillips, Samsung, J.P. Morgan, Maytag, Dupont…
- Savings from Six Sigma at GE
  – 1998 – announced $350 million savings from six sigma
  – later $1 billion

Quality

- The ability of a product or service to meet or exceed customer expectations
- Techniques used to ensure quality:
  - Lean enterprise management
  - Total quality management (TQM)
  - Six Sigma

Quality: Lean Enterprise Management and TQM

- Lean enterprise management
  - A philosophy that considers the use of resources for any purpose other than to create value for the customer to be wasteful and therefore a target for elimination
- TQM
  - A management approach to long-term organizational success through satisfying customer needs

Quality: Six Sigma

- A measurement-based strategy to improve processes and reduce variation through completion of Six Sigma projects
  – Incremental improvement through a process of define, measure, analyze, improve, and control (DMAIC)
  – New product development through a process of define, measure, analyze, design, and verify (DMADV)

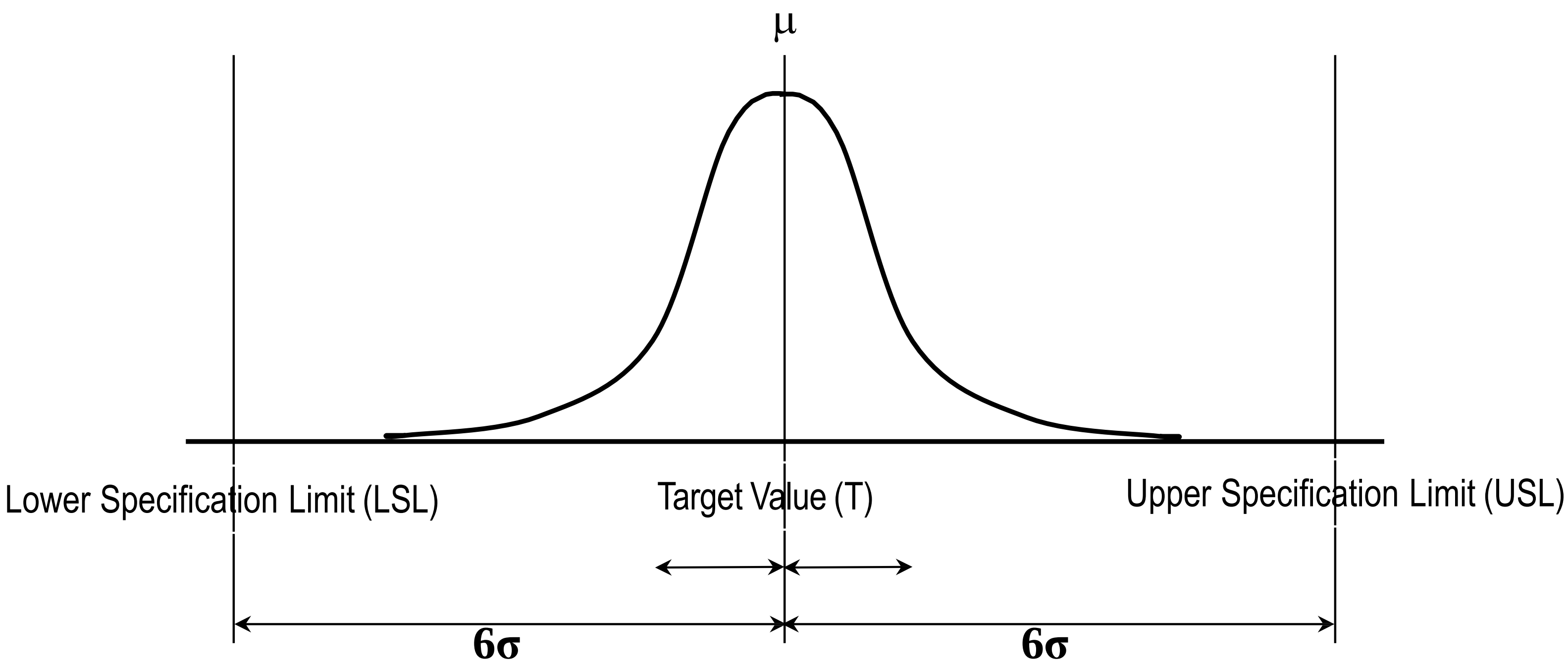
Six Sigma: Definitions

- An improvement program aimed at reducing variability and achieving near elimination of defects from every product, process and transaction
- Broad definition of Six Sigma programs

  "A company wide strategic initiative for process improvement in both manufacturing and service organizations with the clear objective of reducing costs and increasing revenues"
- Objective is to reduce cost and increase revenue: increasing process efficiency and process effectiveness
- Focus on bottom line results

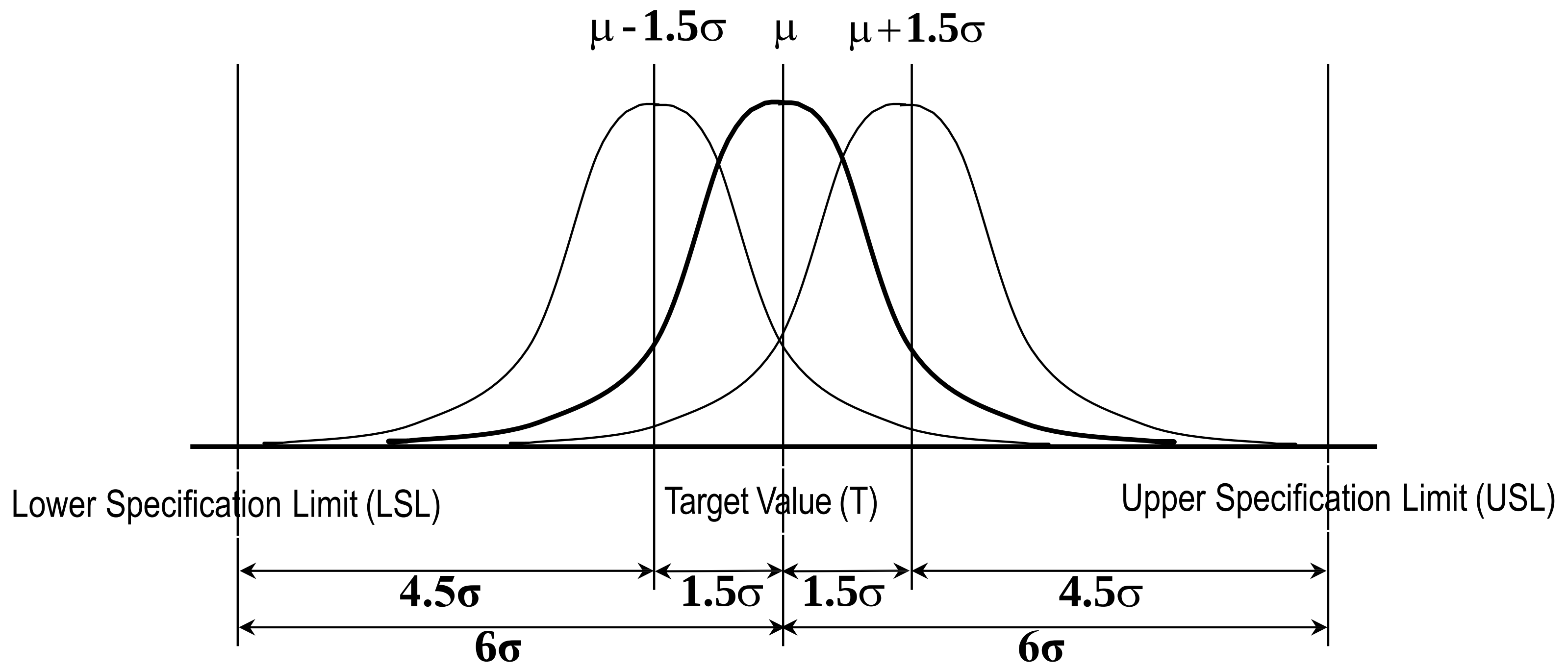
Technical Definition of Six Sigma

- Reduce the variation of every individual process to render no more than 3.4 defects per million opportunities
- Assuming the process output is normally distributed with mean μ and standard deviation σ the distance between the target value and the closest specification limit is at least 6 σ ...



Technical Definition of Six Sigma

- Reduce the variation of every individual process to render no more than 3.4 defects per million opportunities
- Assuming the process output is normally distributed with mean μ and standard deviation σ the distance between the target value and the closest specification limit is at least 6 σ and the process mean is allowed to drift at most 1.5 σ from the target



Six Sigma

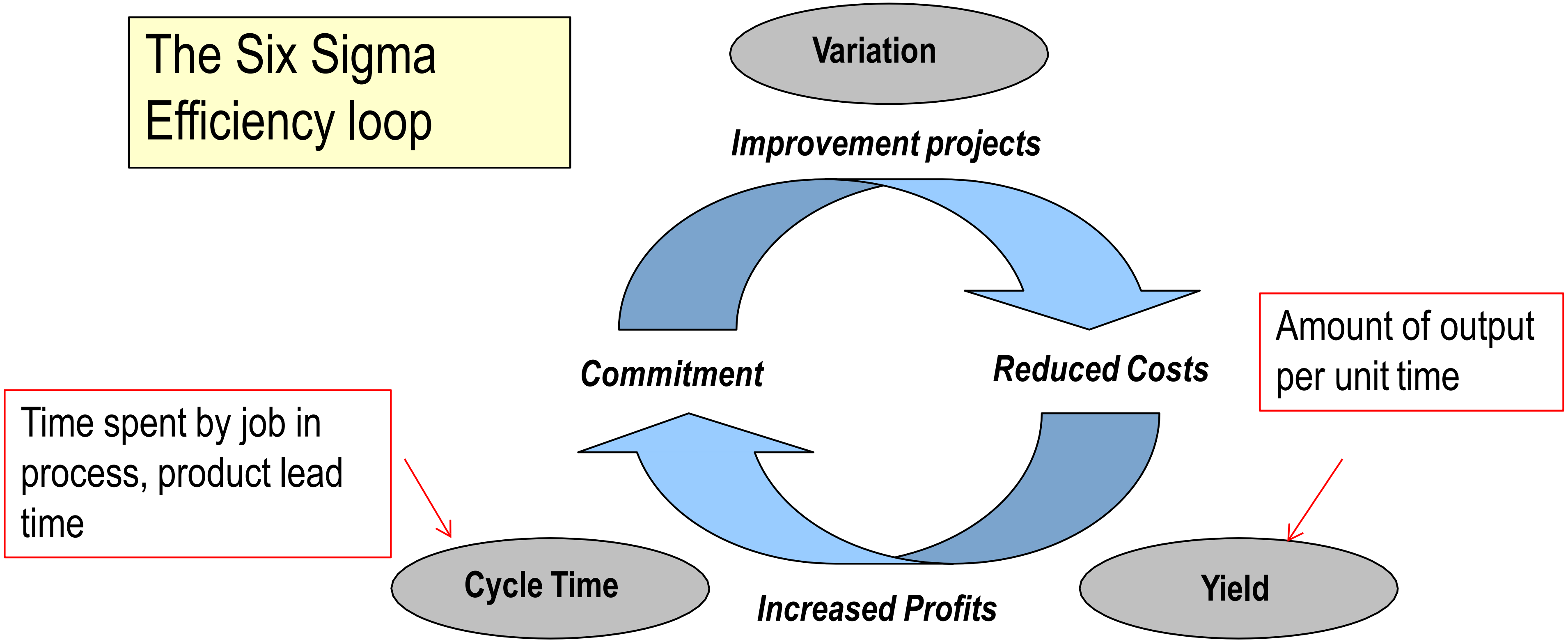
Six Sigma is when distance between the target value and the closest of the specification limits is at least 6σ

Choose which strategy needed, e.g.

- One Sigma = 690,000 DPMO = 31% efficiency
- Two Sigma = 308,000 DPMO = 69.2% efficiency
- Three Sigma = 66,800 DPMO = 93.32% efficiency
- Four Sigma = 6,210 DPMO = 99.379% efficiency
- Five Sigma = 230 DPMO = 99.977% efficiency
- Six Sigma = 3.4 DPMO = 99.9997% efficiency

The Six Sigma Cost or Efficiency Rationale

- Reducing costs by increasing process efficiency has an immediate effect on the bottom line



The Six Sigma Cost or Efficiency Rationale

- A company's profit (or bottom line) is given by:
  - *(Revenue – Cost)*
- Decreasing costs will result in increased profit
- Six Sigma will focus on all type of costs including labor costs
- Labour cost reductions will be realized by increased productivity (NOT layoffs)

The Six Sigma Approach to Cost Reductions

Oriented around the dimensions of variation, cycle time & yield

Variation

- Difference between actual and target (process, product, service)
- Objective is to reduce variation -> improve quality -> reduce costs

Types of Variation

- Can be divided into two main types
  1. ***Common cause or random variation***
  2. ***Special cause or non-random variation***

- Non-random variation
  – Due to: differences in quality of input, faulty equipment, inadequate training of employees
  – First step in reducing the overall variation is to eliminate non-random variation by removing its root causes
- Random variation
  – The result of many different causes
  – Inherent in the process and can only be affected by changing the process design

Understanding the Impact of Variation

- Important concepts in understanding the impact of variation
  - Dispersion
  - Predictability
  - Centering
- Dispersion
  - Magnitude of variation in the measured process characteristics.
- Predictability
  - Do the measured process characteristics belong to the same probability distribution over time?
  - E.g. same standard deviation and mean.
- Centering
  - How well the process mean is aligned with the process target value?

Reducing Variation

- Ideally the process should be predictable, with low dispersion, and well centered

- Standard approach for reducing variability in Six Sigma programs
  1. Eliminate special cause variation to reduce overall dispersion and improve predictability
  2. Reduce dispersion of the predictable process
  3. Center the process to the specified target

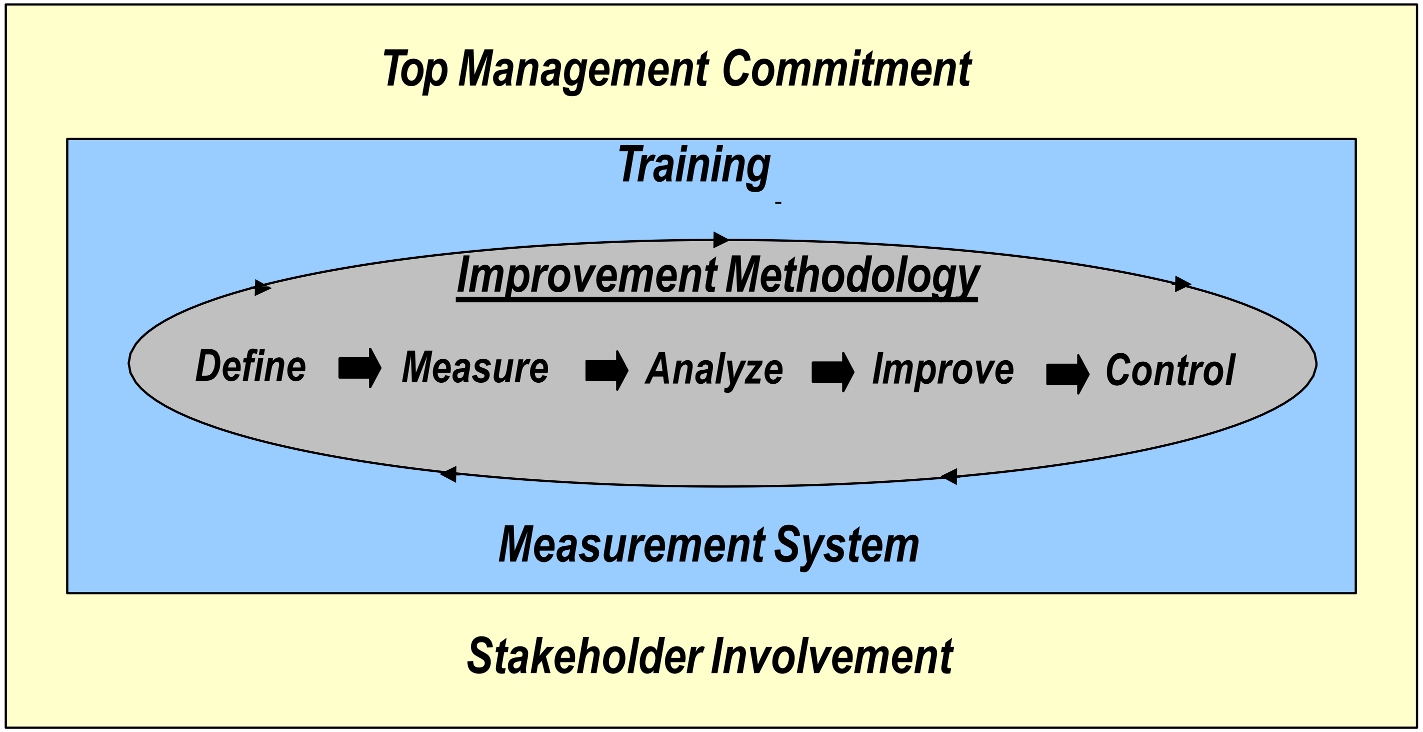
- Six Sigma use traditional tools for quality and process control/analysis
  – Basic statistical tools for data analysis
  – Quality Control tools (the 7 QC Tools)

Cycle Time and Yield

- Cycle time (lead-time, response time)
  – The time a job spends in the process
- Yield (productivity)
  – Amount of output per unit of input or per unit time
- Used to define: input materials, equipment utilization, set up times, capacity
- Improvement in cycle time and yield follow the same tactic as for variation
  – Gain predictability, reduce dispersion and center to target

The Six Sigma Framework

- Centered around a disciplined and quantitatively oriented improvement methodology (DMAIC)
  - Define, Measure, Analyze, Improve, Control



Six Sigma Success Factors

- The bottom line focus and big dollar impact
  - Encourages and maintains top management commitment
- The emphasis on - and consistent use of - a unified and quantitative approach to process improvement
  - The DMAIC methodology provides a common language so that experiences and successes can be shared through the organization
  - Creates awareness that decisions should be based on factual data

Six Sigma Success Factors

- The emphasis on understanding & satisfying customer needs
  – Creates focus on doing the right things right
  – Anecdotal information is replaced by factual data
- The combination of the right projects, the right people and the right tools
  – Careful selection of projects and people combined with hands on training in using statistical tools in real projects

Lean Operations

Toyota applied this philosophy to achieve dramatic efficiency gains

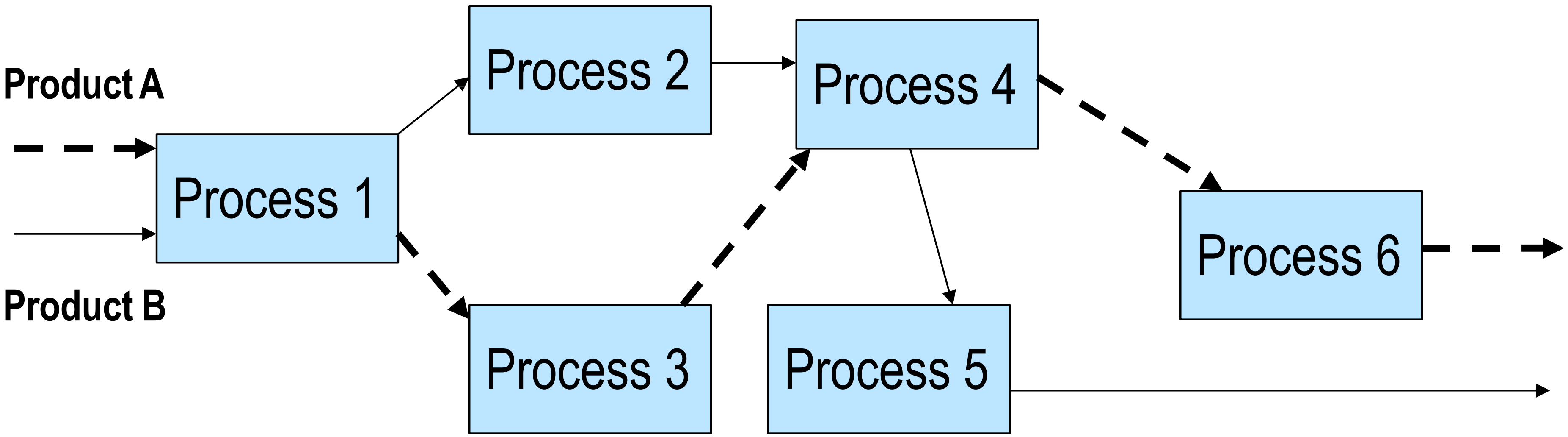
- Toyota Production System
- Improving/Smoothening ‘flow’
  - Just in time philosophy (actual sales vs target sales)
- Waste elimination
  - Transportation (moving products that is not actually required to perform the processing)
  - Inventory (all components, work-in-progress and finished product not being processed)
  - Motion (people or equipment moving or walking more than is required to perform the processing)
  - Waiting (waiting for the next production step)
  - Overproduction (production ahead of demand)
  - Over Processing (due to poor tool or product design creating activity)
- Defects (the effort involved in inspecting for and fixing defects)

http://en.wikipedia.org/wiki/Lean_manufacturing

Video 1 : Lean and Toyoda (14.19 mins)
http://www.youtube.com/watch?v=IVDKzSBE220&list=PLBAFBA30F1A9286FC

Video 2 : The Toyota Production System (7.48 mins)
http://www.youtube.com/watch?v=Vjdil2nBCf0

Processing Networks



Satisfy customer demand in most economical way: right products, right quantities, right times, right places

Process Ideal: Synchronization and Efficiency

- Process synchronisation
  - Ability of process to meet customer demand in terms of their quantity, time, quality and location requirements
- Process efficiency
  - Measured in terms of processing cost

4 “Just rights” of synchronisation

- Exactly what is needed (not wrong or defective)
- Exactly how much is needed (no more no less)
- Exactly when it is needed (not before or after)
- Exactly where it is needed

=> Just-in-time paradigm

Waste and Its Sources

1. Producing Defective products
2. Producing too much product
3. Carrying inventory
4. Waiting due to unbalanced workloads
5. Unnecessary processing
6. Unnecessary worker movement
7. Transporting materials

(7 types of waste in manufacturing by TPS)

Basic Principles of Lean Operations

- Improve process flows
  - Efficient plant layout
  - Fast and accurate flow of material and information
- Increase process flexibility
  - Reduce equipment changeover times and cross-functional training
- Decrease process variability
  - Flow rates, processing times, and quality
- Minimise processing costs
  - Eliminate non-value adding activities s.a. transportation, inspection and rework

Improving Process Architecture

- Functional layout
  - Resources performing same functions are pooled together
    - Fuller utilisation of resource pool in producing a variety of products
    - Division of labour, worker-training, standardisation of work within each function
    - For job shops that process a wide variety of products in small volumes
  - Flow units travel significant distances between various resource pools
  - Narrow focus of workers

Cellular Layouts

- Product-focussed layout
  - All workstations that perform successive operations on a given product (or product family) are grouped together to form a cell
- Advantages
  - Reduce transportation of flow units and move small batches of flow units quickly
  - Facilitates synchronised flows, improved defect visibility, traceability and accountability
- Disadvantages
  - Resources cannot be used by other cells

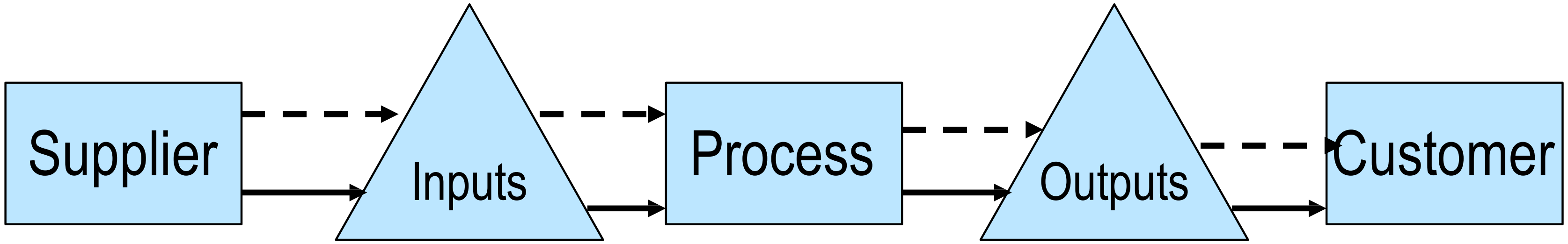
Read: Group Technology and Manufacturing Cells

Improving information and material flow: Demand Pull

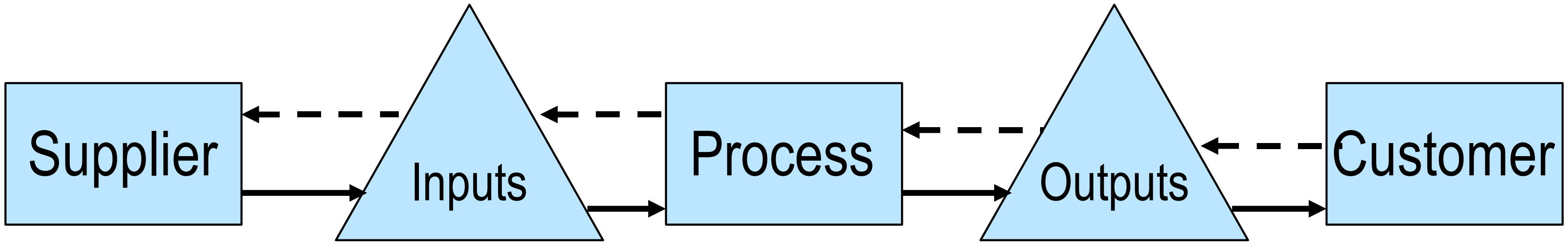
- Push
  - Input availability triggers production, i.e. keep busy to maximise resource utilisation as long as there is work to be done
- Pull
  - Demand from a customer station triggers production so that each station produces only on demand from its customer station

Synchronisation: Supply Push Vs Demand Pull

Supply Push: Input availability triggers production



Demand Pull: Output need triggers production



Demand Signalling – Kanban System

- Pull system: customer needs a signalling device to inform supplier of need
- Kanban
  - Device for customer to inform supplier of its need
  - Card attached to an output flow in the buffer between customer and supplier processes
  - Contains information on
    - Customer process
    - Supplier process
    - Parts description
    - Production quantity
  - As customer withdraws output flow units, attached kanban goes back to supplier, signalling supplier to produce the listed quantity

Improving Process Flexibility: Batch Size Reduction

How much to produce at a time?

- Example
  - 2 different models: people mover, sedan
  - 10,000 units of each model monthly
- Level production
  - Frequent small quantities to match customer demands
  - Alternate production one at a time
  - If demand is stable, i.e. even load, perfect synchronisation
- Changeover costs and batch reduction
  - Reduction of fixed costs associated with each batch
  - Reduce changeover costs by studying and simplifying the changeover process, customising machines, changeover activities while machine running to reduce time

Quality at source: Defect Prevention and Early Detection

- Defect prevention
  - Simplification, standardisation
  - Mistake-proofing (Poka Yoke)
    - Design to minimise chances of defect (e.g. incorrect assembly of parts)
  - Intelligent Automation (Jidoka)
    - Halt machine/process immediately if defective units
- Defect visibility
  - Early detection, e.g. Statistical Process Control to monitor and detect abnormal variations
- Decentralised control
  - Delegate problem solving to the local level

Reducing Process variability

- Standardisation reduces variability
  - changing personnel, change from one production cycle to another, easier to identify sources of waste that can be eliminated
- Planned preventive maintenance
  - Workers handle light maintenance of their machines on an ongoing basis with complete maintenance schedule during off-hours
- Carry safety capacity
  - Trade off between safety capacity and safety inventory

Other principles of Lean Operations

- Visibility of Performance
  – help members of team when problems occurs, celebrate success where possible
- Managing human resources: employee involvement
- Supplier Management

Also look up : Agile Manufacturing (Lean + more)

Improving flows in a supply chain

- Scale magnification
  - E.g. flow times between nodes in a supply chain can be orders of magnitude larger than those between processes within a plant
- Multiple decision makers
  - Different nodes in supply chain with own objectives, etc.
- Asymmetric information
  - Independent decision maker possess local information but lacks global information necessary for synchronisation and efficiency in supply chain.

Reference:

Y. Cheung, J Bal (1999), Managing turbulence in the supply chain, *Published* in *TQM & Innovation, Learning for Innovation, Proceedings of the 4th Conference on ISO9000 and TQM*, Ho S. ed., Hong Kong Baptist University, Hong Kong, pp 248-254.

Quality Tools for Business Process Improvement

See Lecture 6b

Ancient History of Quality

- Romans built on the achievements of the ancient Greeks and Egyptians
  - Standardised designs of bridges and roads
- Babylonian king (1700 BC)
  - Product liability
  - “The builder of a building shall be killed if his/her building falls and kills the owner”.

Recent History of Quality

- Two groups of quality gurus and their key ideas
  - The Americans who brought the messages of quality to Japan and the world
  - The Japanese who developed new concepts in response to the Americans' messages

The Japanese Phenomenon

- Pre World War II
  - poor reputation for quality
  - War brought devastation
- Post War
  - Union of Japanese scientists and Engineers (JUSE)
  - Dr Deming invited to lecture in Japan (JUSE)
  - Emphasis on manufacturing
- Now
  - ‘Quality’ goods and services
  - Consumer expectations
  - Legislation

The USA Scenario

- Deming and Duran were ignored in their home country.
- Quality of goods had a low priority in the USA.
  - World hungry for manufactured goods in 50s & 60s.
  - Emphasis on maximizing output and profit.
- Oil crisis in early 70s intensified competition.
- USA lost markets & market share to Japan.
- Quality movement came back to USA.

Quality

- Feigenbaum: quality is the degree to which a specific product conforms to a design or specification
- Joseph Juran: ‘fitness for use’
- Crosby: quality is free, Zero Defects
- Taguchi: quality control using statistical techniques
- Shingeo Shingo: “Poka-Yoke”
- Ishikawa: QC-tools
- http://www.qualitygurus.com/gurus/

The American “Gurus”

- W Edwards Deming
  - Management philosophy and systems
- Philip Crosby
  - Zero defects (‘do it right first time’) and the cost of quality
- Joseph M Juran
  - Quality trilogy
    - Planning, control and improvement

The importance of quality for the development of companies

Improve quality → Costs decrease because less rework, fewer mistakes, fewer delays, snags, better use of machine-time and materials → Productivity improves

→ Capture market with better quality and lower price → Stay in business → Provide jobs and more jobs..

(Deming, 1996)

The Quality Improvement Process (Deming)

- Strategic quality planning
  - Translating customer needs into product/service features
  - Eight dimensions of quality
  - Quality niche strategy
    - Which dimensions not used by competitors?
    - Areas of emphases
  - Benchmarking

Reference: Chapter 13, Wisner &Stanley, Pg 494

Eight Dimensions of Quality

Quality Dimension (Garvin, 1987)	Hospital	DVD Player
Performance	Surgery performed correctly, problems corrected; no complications	Operates as promised
Features	Free Satellite TV	Has surround sound, MP3 playback, 5 speed scanning
Reliability	Good probability surgery will be effective	Player operates each time it is used
Conformance	Patients get exactly what they expected at the expected price	Player operates according to the manual
Durability	Surgery results will last	Player will last past the warranty period
Aesthetics	Cheerful room	Sleek design; controls easy to read
Serviceability	Easy to schedule follow-up care	East to return for service under the warranty period
Perceived Quality	Hospital has a world renowned doctor and has excellent reputation	Known brand name

The Quality Improvement Process (cont.)

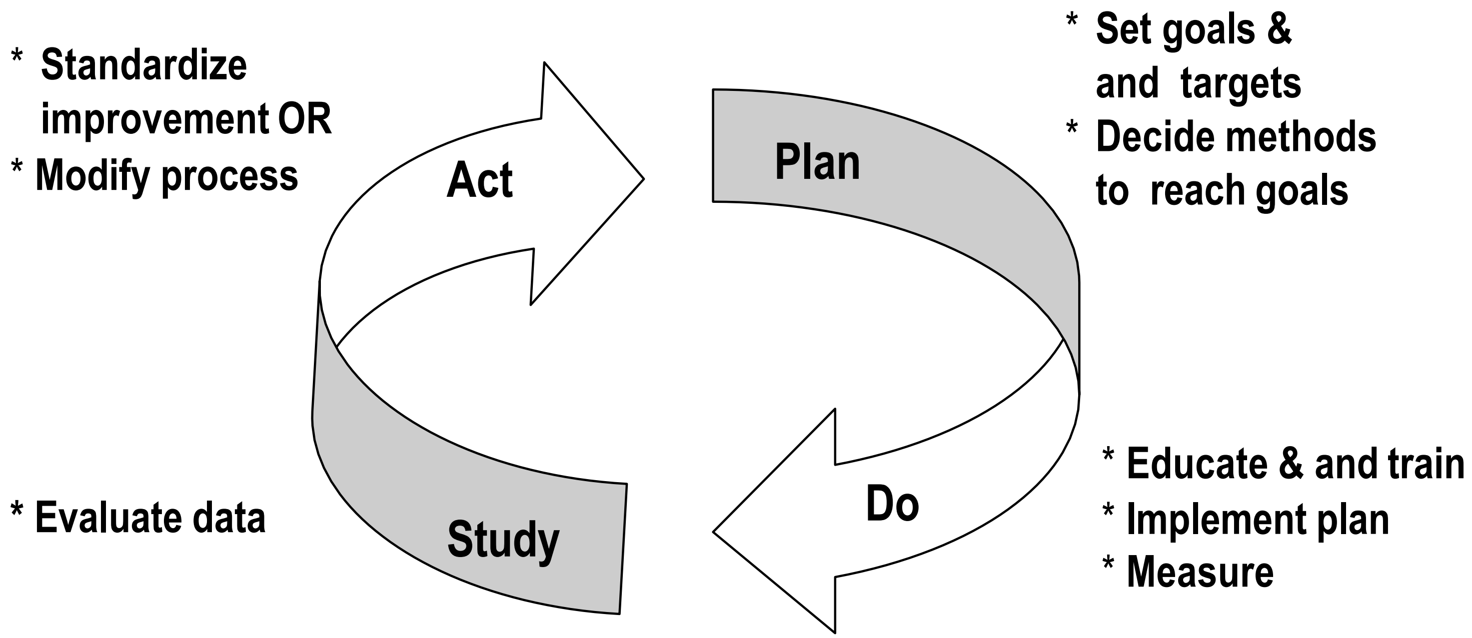
- Implementing the quality plan
  - Key ingredients
    - Top management support; employee involvement; consistent with customer and supplier quality plan
  - Quality maturity matrix (PWC)
    - Innocence, awareness, understanding, competence, excellence
  - Performance measures
    - Return on investments (After Tax income/Total Assets)
    - Value added per employee
      - Sales – Cost (Materials, supplies, ..)/No. of Employees

The Quality Improvement Process (cont.)

- Controlling quality
  - Process variation
    - Common causes (‘Expected’ causes)
    - Assignable causes (not natural or part of process, eg employee motivation
  - A framework for solving quality problems
    - Deming Plan-Do-Study-Act (PDSA) Cycle
    - Applying the PDSA Cycle

The Quality Improvement Process (cont.)

Deming's PDSA Cycle



W&S, Figure 13.2, Pg 503

The Quality Improvement Process (cont.)

- Detecting problems and assignable causes
  – Check sheets
  – Pareto charts
  – Case-and-effect diagram (fishbone, Ishikawa)

Crosby's Quality Principles

- Quality means conformance to requirements
  - Requirements must be clear
- Quality comes from prevention
- Quality performance standard is zero defects
- Quality measurement is the price of non conformance
  - Manufacturing companies spend 25% of the sales cost doing things wrong
  - Service companies spend 40% of their operating cost on the same wasteful actions

Crosby's Quality Cost Categories

- Price of conformance (POC)
  – Good cost, something done right the first time
- Price of non-conformance (PONC)
  – Bad cost, not sure if done right the first time
- Compare with value-adding activities and non-value adding activities

Process and Quality

- Costs of quality
  - Appraisal costs
  - Internal failure costs
  - External failure costs
  - Prevention costs
- Quality is Free (Crosby)

The Japanese “Gurus”

- Kaoru Ishikawa
  –Simple tools, quality control circles,
  Company-wide quality
- Shingeo Shingo
  – Fool proofing and zero defects
- Yoshio Kondo
  – Four steps for making creative and quality work

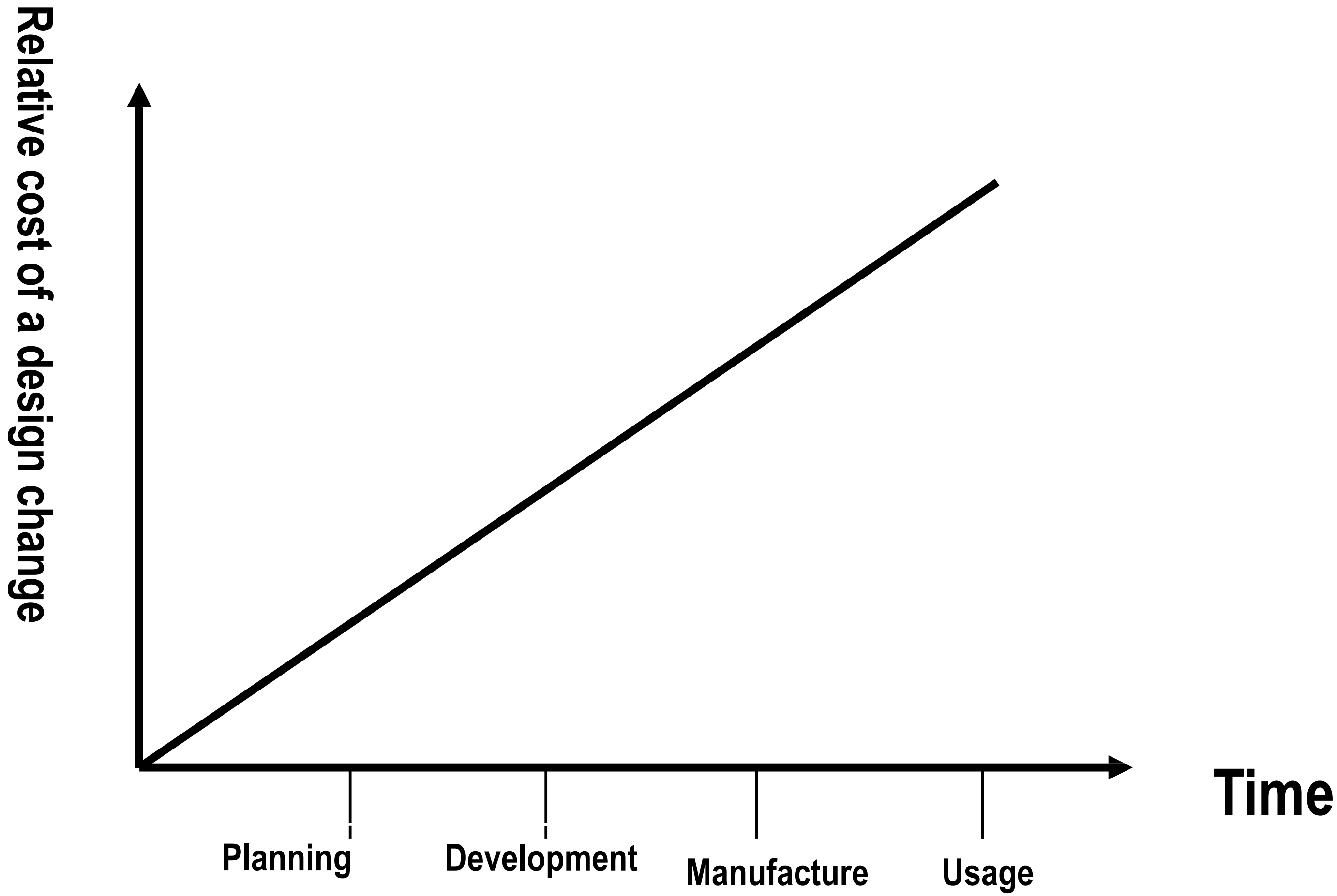
Scope of Quality

- Product
  - All goods and services whether for sale or not
- Processes
  - All processes in all businesses
- Stakeholders
  - Customers, community groups, suppliers, etc
- Industries
  - Manufacturing, service, government, non-profit

Quality Costs

- Traditional indices:
  - % scrap, rework hours, no. of warranty claims, etc
- Uses:
  - draw attention to need for quality improvement
  - focus area where action is needed, resources should then be committed to improvement
  - as a measure of improvement
  - as an ongoing measure of quality performance

Cost of a design change



Quality Cost Categories

- Prevention
  - “The cost of any action taken to investigate, prevent or reduce defects and failures” (BS6143)
- Appraisal
  - “The cost of inspecting, testing or otherwise checking to detect defects or failures if they are present”
- Failure
  - “The cost incurred when something has not been done “Right First Time”.

New Car Example

- Internal failure costs
  - Costs generated before a car is shipped to a dealer because of defects in the build quality
  - Quality assurance on the assembly line
  - E.g. rework hours, % scrap, etc.
- External failure costs
  - Costs generated as result of defects
    - Identified by dealer
    - Experienced by customer
  - E.g. no. of warranty claims, recall costs, processing of customer complaints

Summary

- Six Sigma Quality concept
- Ways of implementing Six sigma quality
- Lean concepts
- Quality tools and their role in applying lean concepts

- Essential Reading : Laguna and Marklund, Chapter 2