Università degli Studi di Trento
Dipartimento di Ingegneria e Scienza dell'Informazione
Corso di Laurea in Ingegneria Informatica, delle Comunicazioni ed Elettronica (ICE)

Organizzazione e Gestione Aziendale

La gestione della Qualita'

Lean Management

Prof. Marco Formentini
Università degli Studi di Trento, 7 Maggio 2023

Agenda della sessione

- Definire la natura e l'importanza della qualità nella gestione dei processi aziendali
- Decidere la misurazione della qualità e definire gli standard
- Gli strumenti per la gestione della qualità
- Lean Management e Just-in-Time
- Come implementare la lean synchronisation?

La logica decisionale per la gestione della qualità e il miglioramento dei processi

UNIVERSITY OF TRENTO

La qualità e' definita in modo adeguato?

↓

La qualità e' misurata in modo adeguato?

↓

La qualità e' controllata in modo adeguato?

↓

In che modo si identificano le cause dei problemi?

↓

MIGLIORAMENTO

- In questa sessione esploreremo assieme le domande chiave in questa logica sequenziale diagnostica:
- Con obiettivo finale (ma iterativo!) il miglioramento dei processi aziendali.

Quale hamburger offre la qualità migliore?

UNIVERSITY OF TRENTO

UNIVERSITY OF TRENTO

Definire il concetto di qualità

Le definizioni di qualità

UNIVERSITY OF TRENTO

- **Quante diverse prospettive?**

Cinque categorie proposte da Garvin (1984)

- **product-based – *un insieme di determinate caratteristiche***
- **manufacturing-based – *senza difetti***
- **value-based - *qualità vs. costo/prezzo***
- **user-based – "*fitness for purpose*"**
- **transcendent – *eccellenza innata e intangibile***

Inoltre….

- **gap-based – *aspettative e percezioni***

UNIVERSITY OF TRENTO

Misurare la qualità

Quality Management

UNIVERSITY OF TRENTO

- **Le dimensioni della qualità**

- **"La qualità e' la totalita' delle specifiche e delle caratterisitche di un prodotto o servizio su cui si basa la sua abilita' di soddisfare determinati bisogni"** (American National Standards Institute (ANSI) and American Society for Quality Control (ASQC))
- **Alcune dimensioni della qualità:**
  - Performance: main characteristics
  - Aesthetics: appearance, feel, smell, taste
  - Features: extra characteristics
  - Conformance: how well product/service conforms to customer's expectations
  - Reliability: consistency of performance
  - Durability: useful life
  - Perceived Quality: indirect evaluation of quality (e.g. reputation)
  - Service after sale: handling of customer complaints or checking on customer satisfaction

Certificazione della Qualità ISO 9001

UNIVERSITY OF TRENTO

- **La Certificazione della Qualità ISO 9001 è uno standard internazionale applicabile da tutte le organizzazioni, operanti in qualsiasi settore di attività.**

- E' basata su otto principi di gestione per la qualità (tutti indispensabili per una buona conduzione aziendale).
  - Focalizzazione sul cliente
  - Leadership
  - Coinvolgimento del personale
  - Approccio per processi
  - Approccio sistemico alla gestione
  - Miglioramento continuo
  - Decisioni basate su dati di fatto
  - Rapporti di reciproco beneficio con i fornitori

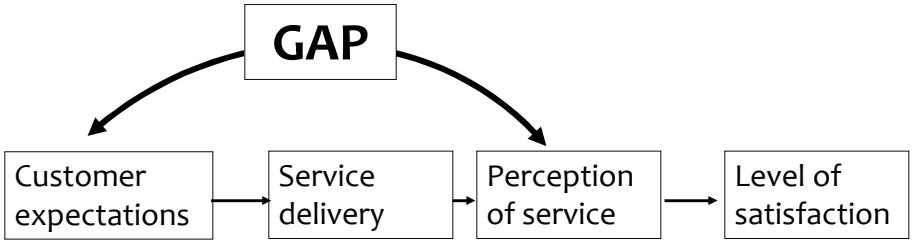
The gap view of quality

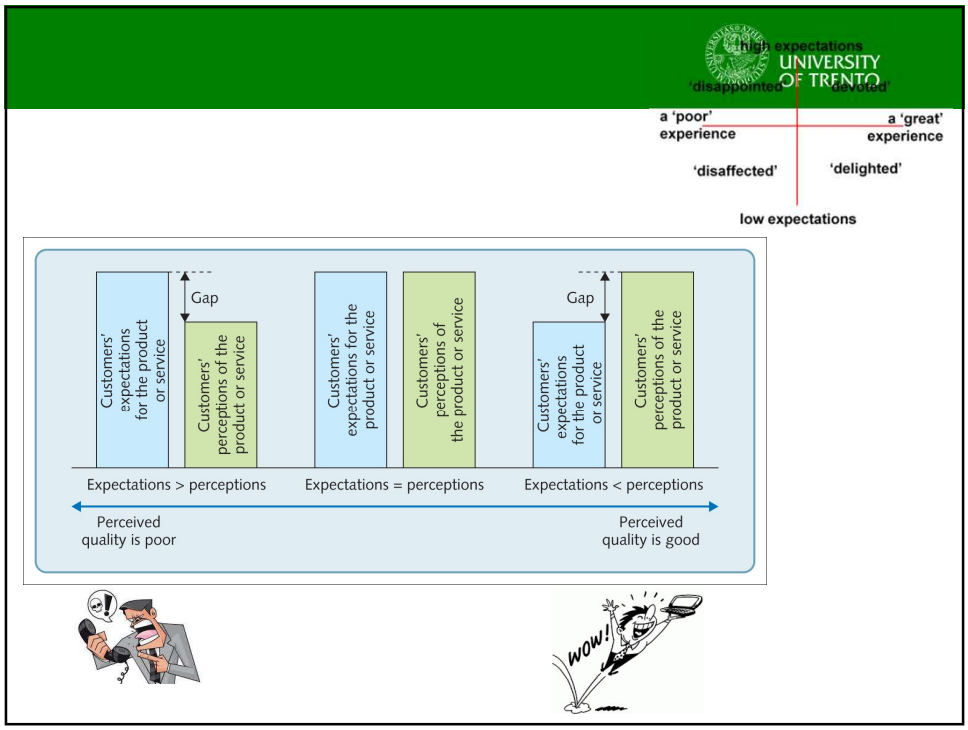
UNIVERSITY OF TRENTO

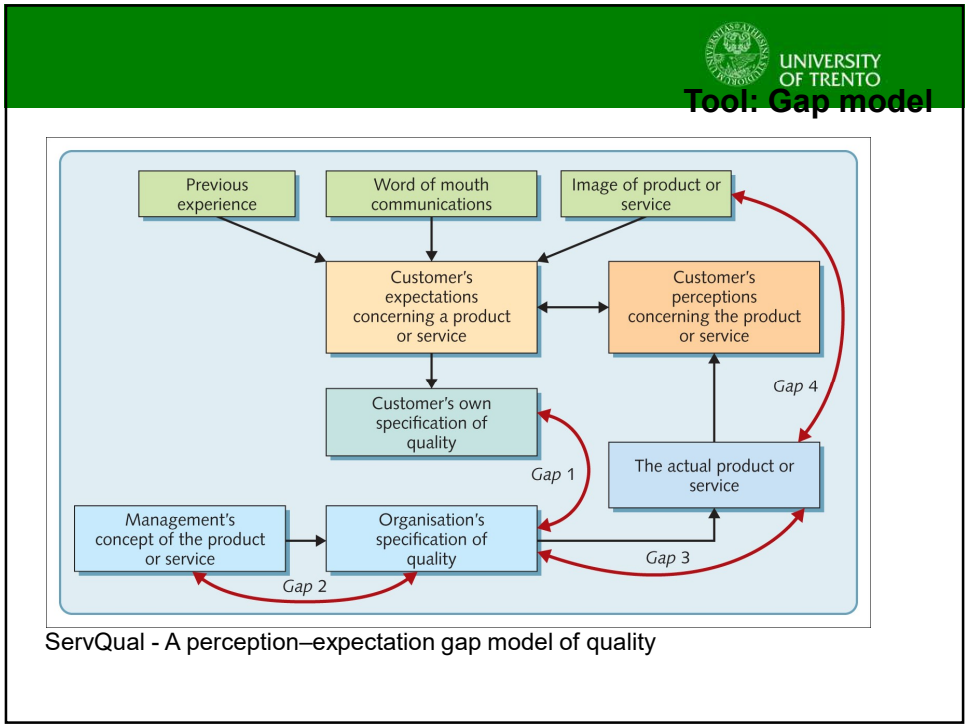
Dr. A. Parasuraman

Valarie Zeithaml

Leonard Berry







ServQual - A perception–expectation gap model of quality

Decidere le misure e definire gli standard

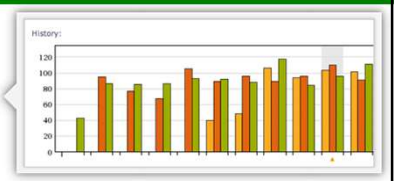
UNIVERSITY OF TRENTO

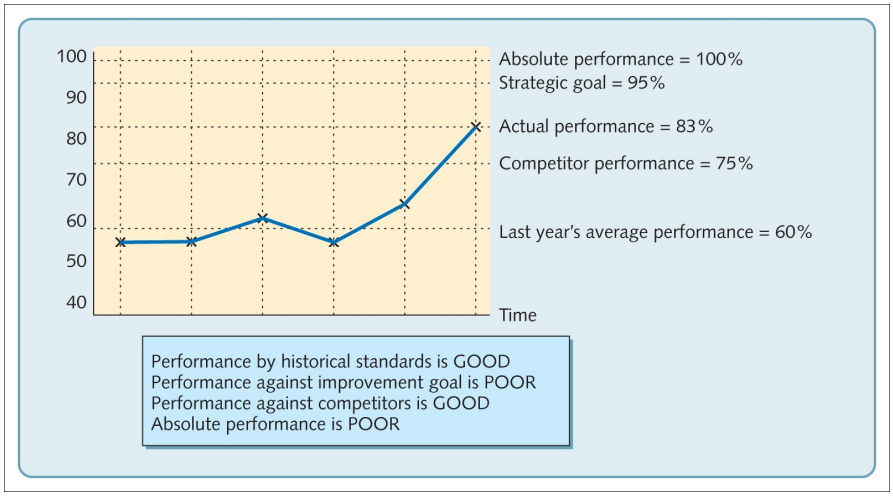
- Misurazione oggettiva o soggettiva?
- Assoluta o relativa?
- Chi lo dice? Clienti, staff, o managers?
- Critiche o commenti?
- Prevenzione o riparazione?

Definire gli obiettivi:

UNIVERSITY OF TRENTO

- Obiettivi basati su dati storici
- Obiettivi strategici
- Obiettivi basati su performance esterne
- Obiettivi di performance assoluta



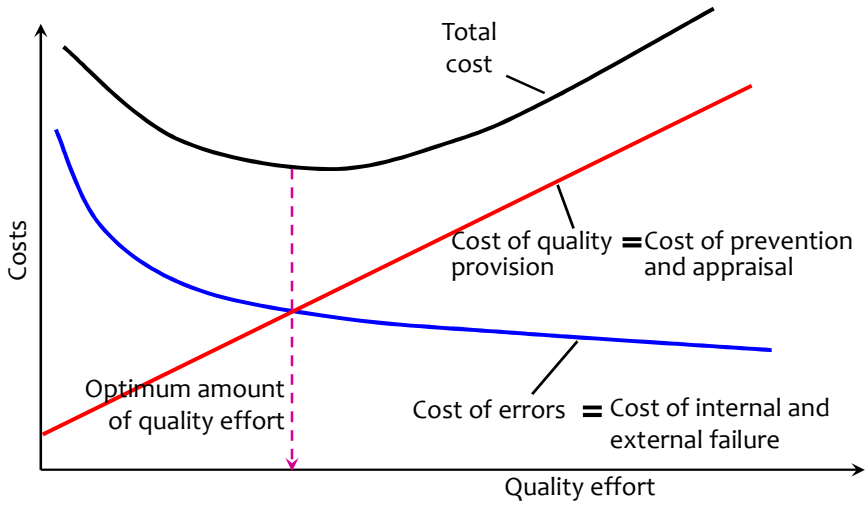


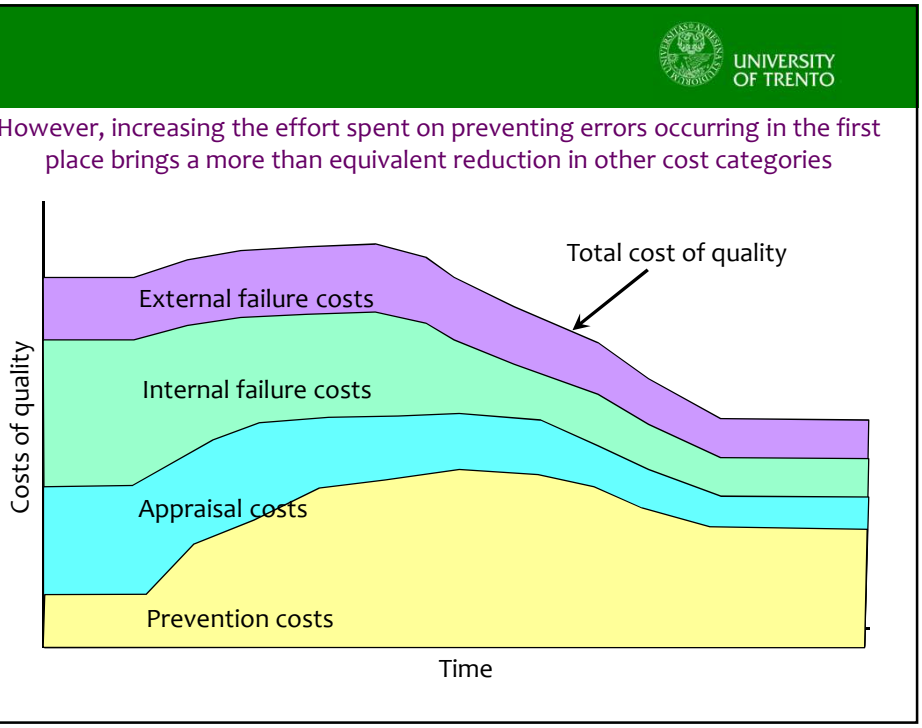
Different standards of comparison give different messages

Quali sono i costi della qualità?

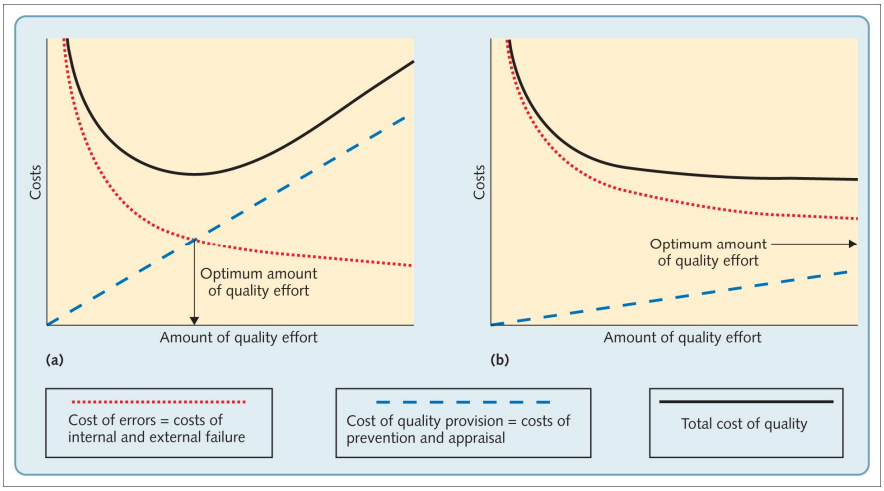
Category of quality related cost	*Includes such things as:*
Prevention costs – those costs incurred in trying to prevent problems, failures and errors from occurring in the first place	• Identifying potential problems and putting the process right before poor quality occurs • Designing and improving the design of products and services and processes to reduce quality problems • Training and development of personnel in the best way to perform their jobs • Process control
Appraisal costs – those costs associated with controlling quality to check to see if problems or errors have occurred during and after the creation of the product or service	• The setting up of statistical acceptance sampling plans • The time and effort required to inspect inputs, processes and outputs • Obtaining processing inspection and test data • Investigating quality problems and providing quality reports • Conducting customer surveys and quality audits
Internal failure costs – failure costs that are associated with errors dealt with inside the operation	• The cost of scrapped parts and materials • Reworked parts and materials • The lost production time as a result of coping with errors • Lack of concentration due to time spent troubleshooting rather than improvement
External failure costs – failure costs that are associated with errors being experienced by customers	• Loss of customer goodwill affecting future business • Aggrieved customers who may take up time • Litigation (or payments to avoid litigation) • Guarantee and warranty costs • The cost to the company of providing excessive capability (too much coffee in the pack and too much information to a client)

L'approccio tradizionale nella gestione della qualità



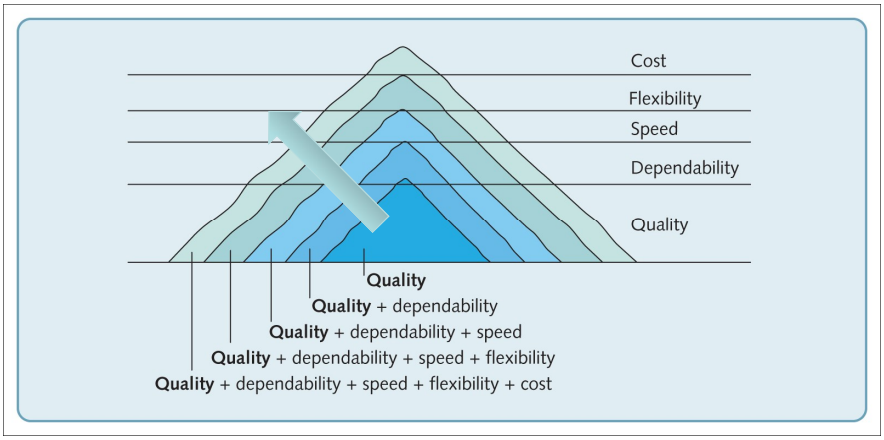


How much effort should we put into quality?



(a) The traditional cost of quality model; (b) a more modern view

Il modello del cono di sabbia



The sandcone model of improvement: cost reduction relies on a cumulative foundation of improvement in the other performance objectives

UNIVERSITY OF TRENTO

Controllare la qualità

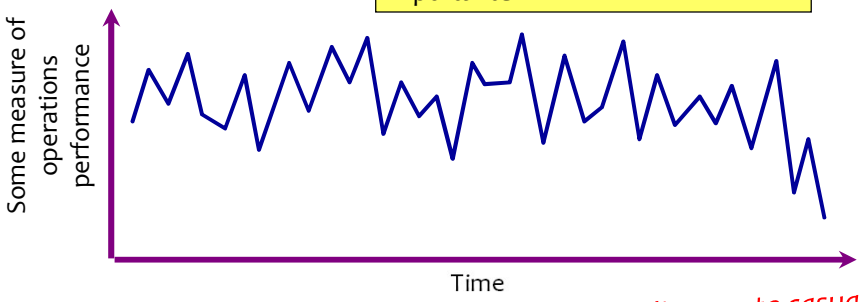
Controllo di processo

UNIVERSITY OF TRENTO

L'origine del Six Sigma, e il suo focus centrale, e' il controllo di processo

Alcuni aspetti della performance di un processo possono essere misurati nel tempo.

"Ma perche' la variazione e' importante?"



"E in che modo sappiamo che la variazione e' semplicemente casuale, oppure puo' essere indicativa di alcune cause nel processo?"

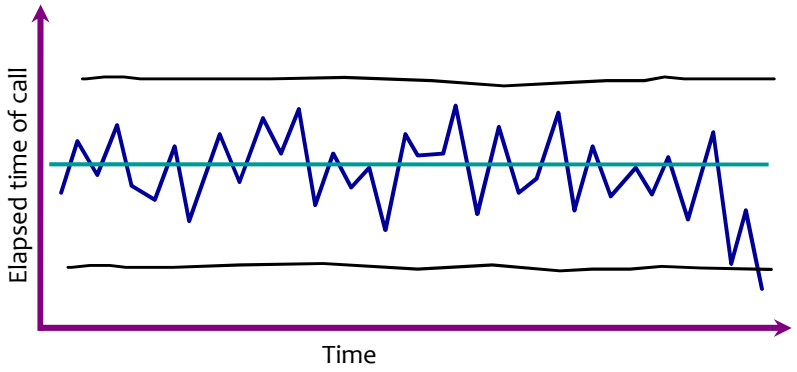
Controllo di processo

UNIVERSITY OF TRENTO

L'ultimo punto rappresentato sul grafico sembra stranamente basso.

In che modo possiamo sapere se e' una variazione casuale, oppure e' il risultato di un cambiamento nel processo, che dovrebbe essere quindi analizzarto attentamente?

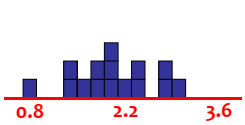
Alcune "linee guida" o "limiti di controllo" sarebbero utili!



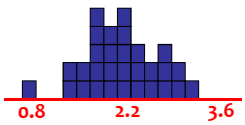
Process control charting

UNIVERSITY OF TRENTO

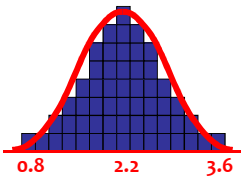
Effettuando un campionamento...



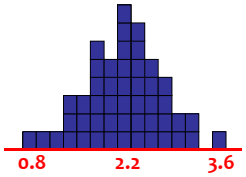
After the first sample



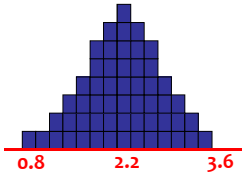
After the second sample



Fitting a normal distribution to the histogram of sampled call times



By the end of the day

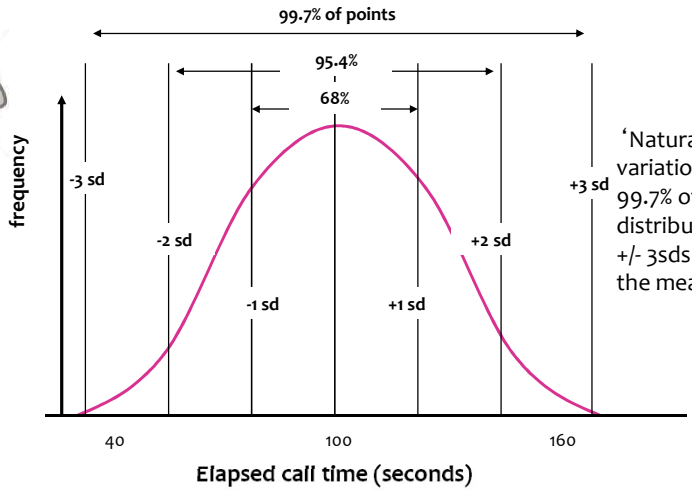


By the end of the second day

La variazione naturale di molti processi puo' seguire una distribuzione normale.

Standard deviation is a measure of spread (variation) of a distribution

UNIVERSITY OF TRENTO

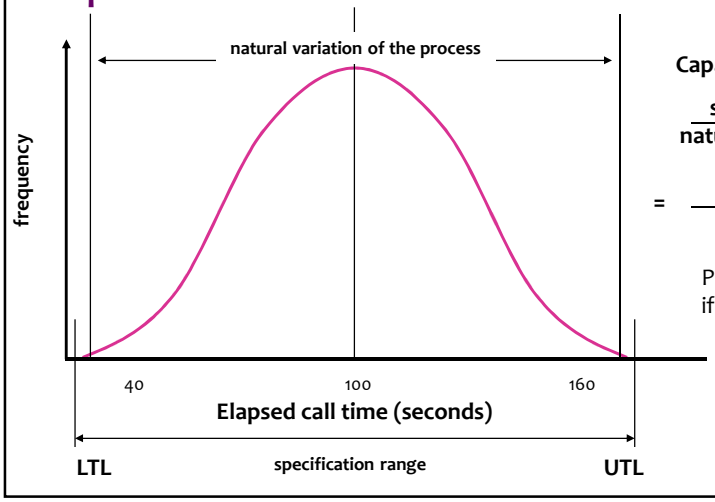


'Natural' variation is the 99.7% of the distribution – i.e. +/- 3sds from the mean

Possiamo utilizzare la distribuzione normale per definire le linee guida

UNIVERSITY OF TRENTO

In questo modo possiamo stabilire se un processo e' in grado di soddisfare i requisiti:



Capability (Cp) =

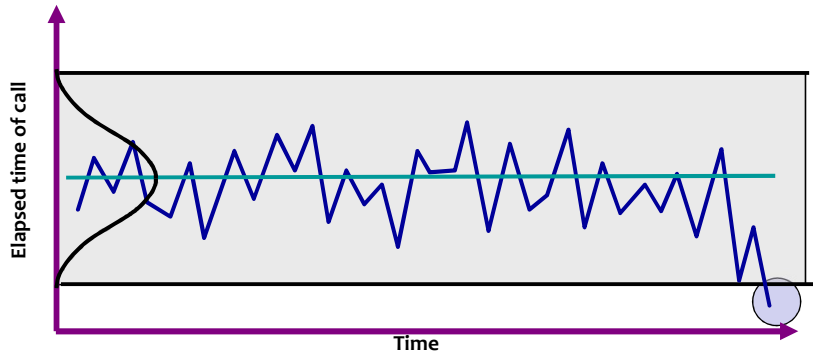
$$\frac{\text{specification range}}{\text{natural process variation}} = \frac{\text{UTL-LTL}}{6s \text{ (i.e. +/- 3 sd's)}}$$

Process is 'capable' if the *Cp* >1

Process control charting

UNIVERSITY OF TRENTO

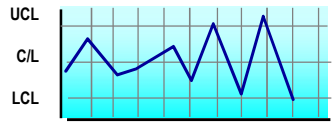
- If we understand the normal distribution which describes random variation when the process is operating normally (ie. when the process is "in Control") then we can use the distribution to draw the control limits
- In this case the final point is very likely to be caused by an 'assignable' cause, ie. the process is likely to be out of control



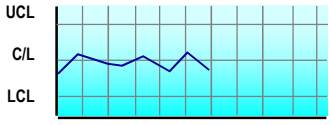
Process control charting

UNIVERSITY OF TRENTO

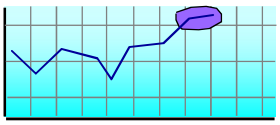
Showing 'Upper', 'Control' and 'Lower' control level…



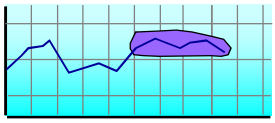
Alternating and erratic behaviour - Investigate



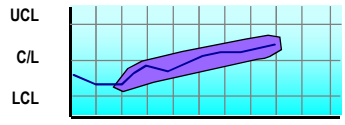
Suspiciously average behaviour - Investigate



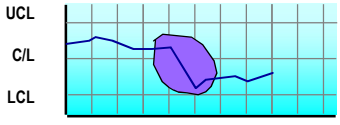
Two points near control limit - Investigate



Five points one side of centre line - Investigate



Apparent trend in one direction - investigate



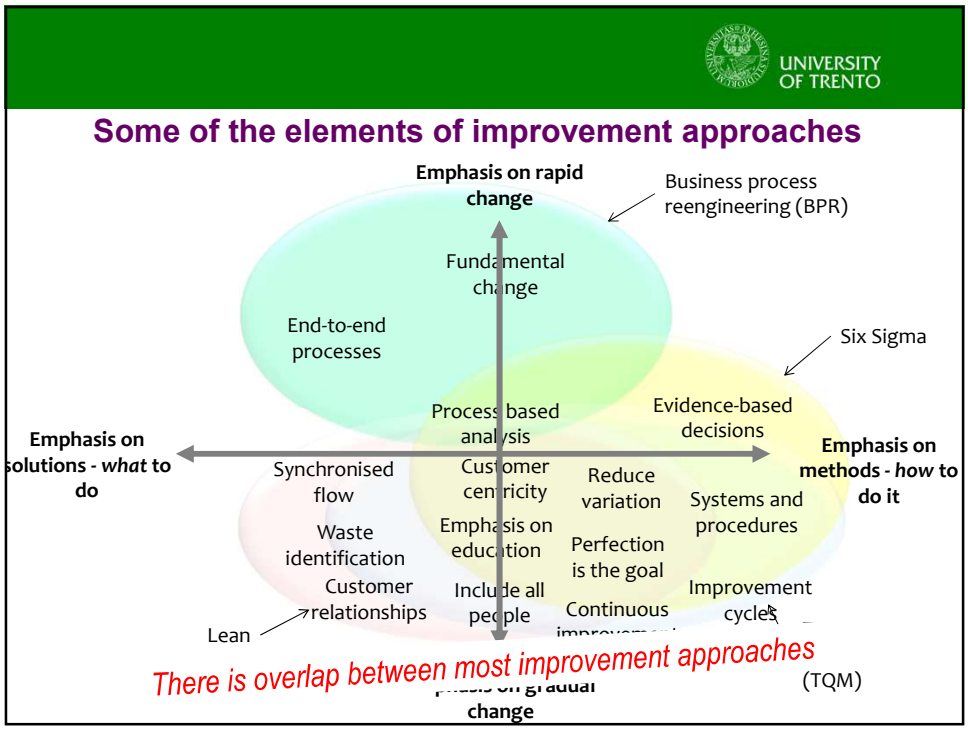
Sudden change in level - Investigate

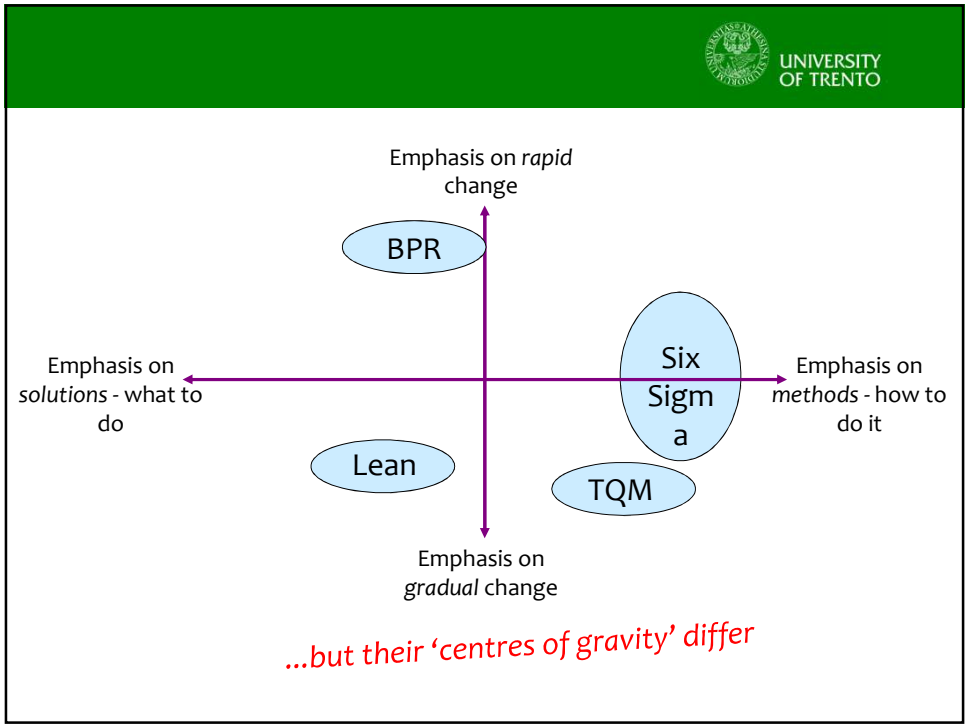
In addition to point falling outside of the control limits, other sequences of unlikely points should be investigated

UNIVERSITY OF TRENTO

Approcci differenti alla gestione della qualità e del miglioramento dei processi

	Breakthrough improvement (Business process reengineering)	***Continuous improvement (TQM, Six Sigma, Lean Manufacturing)***
Duration	Short-term	Long-term
Pace	Big steps	Small steps
Change	Abrupt	Incremental
Involvement	A few “champions”	Everyone
Approach	Individualistic	Collective
Stimulus	New inventions, new theories, new technology	Conventional know-how
Risks	Concentrated	Spread over many projects
Investment & efforts	Large investment but small effort over time	Small investment but large effort over time
Effort focus	Technology	People
Evaluation	Profit	Better results in general


UNIVERSITY OF TRENTO
Some of the elements of improvement approaches
Emphasis on rapid change
Business process reengineering (BPR)
Fundamental change
End-to-end processes
Six Sigma
Process based analysis
Evidence-based decisions
Emphasis on solutions - what to do
Emphasis on methods - how to do it
Synchronised flow
Customer centricity
Reduce variation
Systems and procedures
Waste identification
Emphasis on education
Perfection is the goal
Customer relationships
Include all people
Continuous
Improvement cycles
Lean
There is overlap between most improvement approaches
(TQM)
change


UNIVERSITY OF TRENTO
Emphasis on rapid change
BPR
Six Sigma
Emphasis on solutions - what to do
Emphasis on methods - how to do it
Lean
TQM
Emphasis on gradual change
...but their 'centres of gravity' differ

Lean Manufacturing

UNIVERSITY OF TRENTO

- https://www.youtube.com/watch?v=P-bDlYWuptM
  - Lean Thinking/Synchronization…

34

What is the Lean Operations Philosophy ?

UNIVERSITY OF TRENTO

- Waste is *undesirable*. *GOAL:* Zero waste
- High *quality* is essential. *GOAL:* Zero defects
- *Just-In-Time* is essential. Pull instead of push.

  GOAL: Low inventories
- Any difficulty in achieving the above three goals provides an opportunity to improve the process.

The Toyota Production System

UNIVERSITY OF TRENTO

"the benchmark for lean management"

Based on two *philosophies*:

1. Elimination of waste (***muda*** – *horse not carrying a load - 无驮*)
2. Respect for people

Taiichi Ohno
(1912 - 1990)

Video

Respect for People

UNIVERSITY OF TRENTO

- **Level payrolls (constant workforce - no layoffs)**
  - Lifetime employment of core workers
  - Recruitment of temporary workers
- **Cooperative employee unions**
- **Bottom-round management style**
  - Workers are trained to continuously improve the process (***kaizen*** – *change for the better* **改善**) – get to the root problem
  - Workers can also stop the process (line) to address short-term quality problems (***jidoka*** – *autonomation* **自动化** and ***Andon Cord*** – *cord to trigger "Paper Lantern" to light up* - **行灯**)
- **Quality circles (Small Group Involvement Activities or SGIA's)**

Toyota's View of Waste

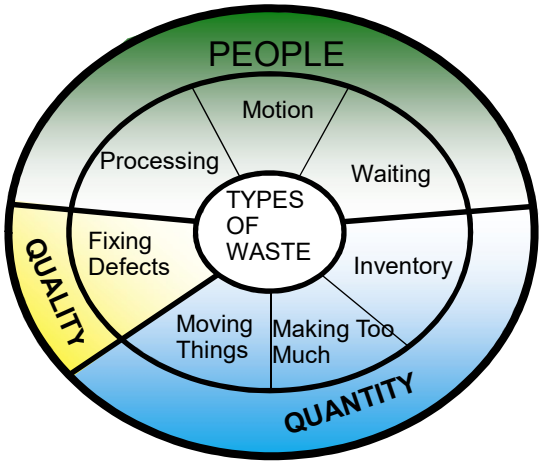
UNIVERSITY OF TRENTO

Waste is 'anything other than the *minimum* amount of equipment, materials, parts, space, and worker's time, which are absolutely essential to *add value* to the product.'

— Shoichiro Toyoda
Chairman, Toyota
(1992 – 1999)

Summarizing: The 7 Forms of Waste

UNIVERSITY OF TRENTO



How to Reduce Waste? Tool 1 - Value Stream Mapping

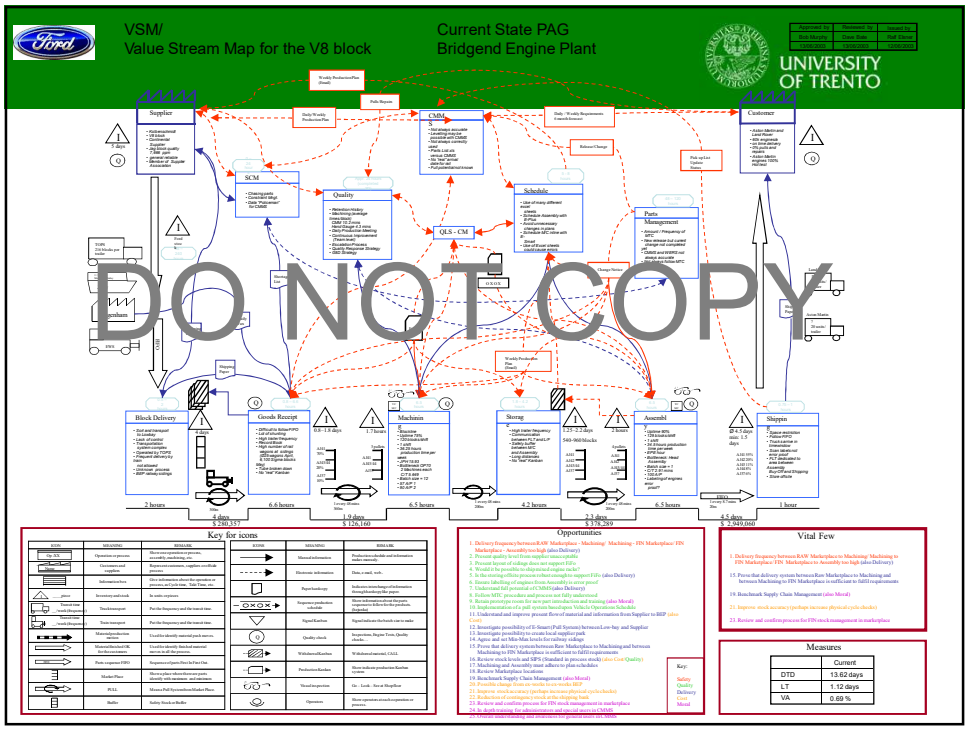
UNIVERSITY OF TRENTO

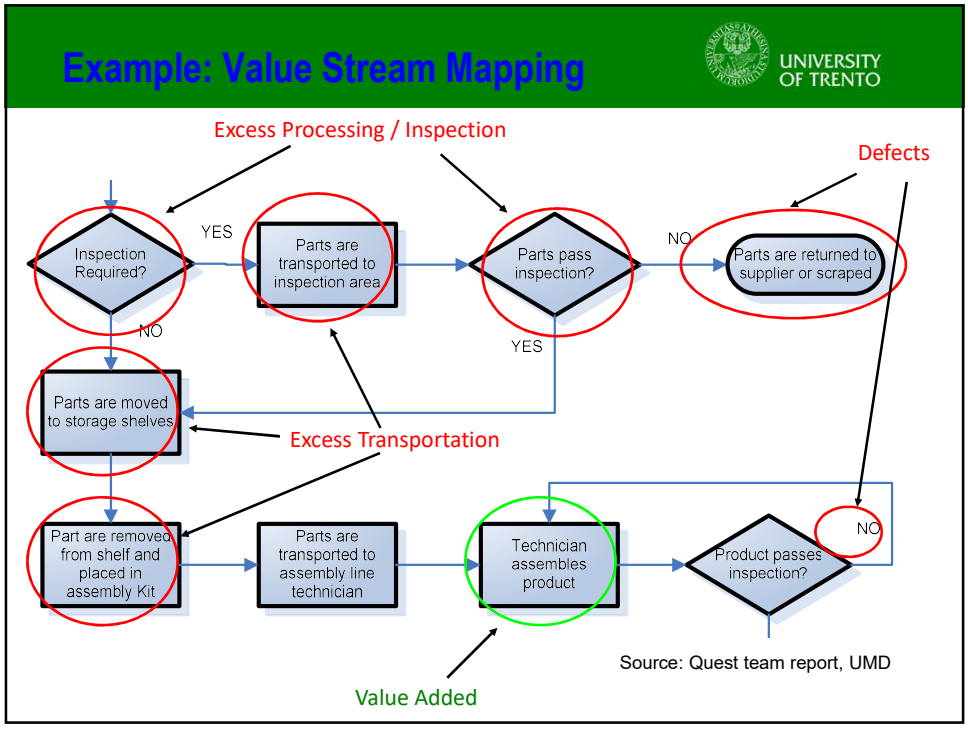
- **Value Added activities (VA): activities in a process for which a customer is willing to pay for**
  - Nursing care, surgery, patient treatment
  - A worker assembling a wheel in a car
- **Non-value Added activities (NVA): activities for which the patient is not willing to pay for, and are not necessary for business**
  - A nurse walking 50 ft to another room to search for supplies
  - Retrieving inventory from warehouse
- **Business Non-value Added (BNVA): activities for which the patient is not willing to pay for, but are necessary for accounting, legal, or regulatory purposes**
  - Preparing financial statements
  - Disclosing information to regulatory agencies

What is Value Stream Mapping?

UNIVERSITY OF TRENTO

- **Essentially, a process flow chart, with activities being labeled as VA, BNVA, or NVA**
- **More information may be added**
  - Changeover time
  - Processing time per unit; cycle time
  - Wait (queue) time
  - Estimated cost
- **Objective: look for waste reduction through removal or reduction of NVA activities**


VSM/
Value Stream Map for the V8 block
Current State PAG
Bridgend Engine Plant
UNIVERSITY OF TRENTO
DO NOT COPY
Key for icons
Opportunities
Vital Few
Measures


Example: Value Stream Mapping
UNIVERSITY OF TRENTO
Excess Processing / Inspection
Defects
Inspection Required?
YES
NO
Parts are transported to inspection area
Parts pass inspection?
NO
YES
Parts are returned to supplier or scraped
Parts are moved to storage shelves
Excess Transportation
Part are removed from shelf and placed in assembly Kit
Parts are transported to assembly line technician
Technician assembles product
Product passes inspection?
NO
Source: Quest team report, UMD
Value Added

Process Efficiency

UNIVERSITY OF TRENTO

$$\text{Process Efficiency} = \frac{\text{Time spent in value-added activities}}{\text{Total process time (Lead Time)}}$$

Example: previous Value Stream Map

Activity	Type	Time (min)
Transport parts to inspection area	NVA	5
Inspect parts	NVA	3
Move parts to storage shelves	NVA	10
Remove parts from shelf and place in assembly kit	NVA	15
Transport parts to assembly line technician	NVA	5
Assemble parts	VA	13
Inspect assembly	NVA	3

$$\text{Process efficiency} = \frac{13}{5+3+10+15+5+13+3} = \frac{13}{56} = 0.23 = 23\%$$

How to Reduce Waste? Tool 2 - Reducing Waste Through 5S

UNIVERSITY OF TRENTO

- **5S is a system of procedures that are used to organize and arrange the workplace, to optimize performance, cleanliness, safety**

Japanese S	*English S*
Seiri 整理	Sorting
Seiton 整顿	Set in order
Seiso 清扫	Sweeping (or Shine)
Seiketsu 清洁	Standardization
Shitsuke 身美 (纪律)	Self-Discipline (or, Sustain)

Example of 5S Implementation (Black & Decker Plant at Hampstead, MD)

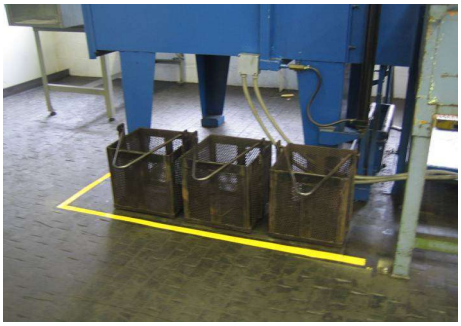
UNIVERSITY OF TRENTO

BEFORE

Simple stuff will improve productivity and lower waste significantly

AFTER

"One place for each thing each thing at its place"



Just-In-Time

UNIVERSITY OF TRENTO

Synchronize production flow with demand

1. Produce at the rate of customer demand
   - Mixed model production – *Heijunka* 平准化 even flow by volume and product
   - Small batch size & reduce setup time/cost – SMED – see next slide
2. Use Pull system instead of Push
   - Kanban based pull – *Kanban* 看板 visual card – signaling a need for an item – see later slides
   - Make-to-order – produce based on customer orders

Minimizes Inventory
➔ Exposes Quality / Process Problems

UNIVERSITY OF TRENTO

How to Reduce Batch Sizes? By Decreasing Setup Cost / Time

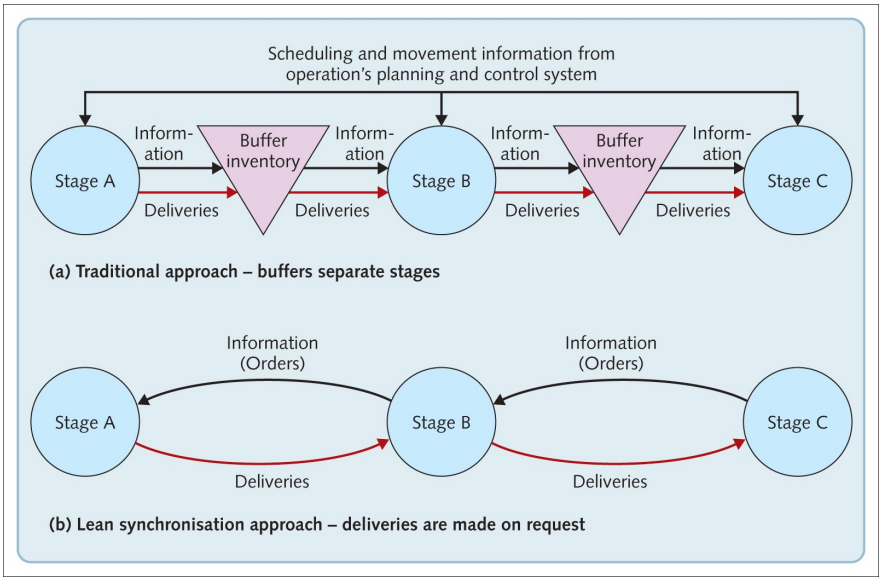
- Batch size (and consequently average inventory) increases with setup cost
- To reduce batch size, you need to reduce setup cost (or setup time)
- SMED – Single Minute Exchange of Dies
  - This is a group of techniques applied to reduce setup (or changeover) times in manufacturing
  - Starts with documenting (e.g., filming) the changeover process
  - Then, one designs fixtures, trays, change layout, and other actions to avoid time wasted during setup
  - May include activities as simple as positioning necessary tools for changeover closer to setup operation

UNIVERSITY OF TRENTO

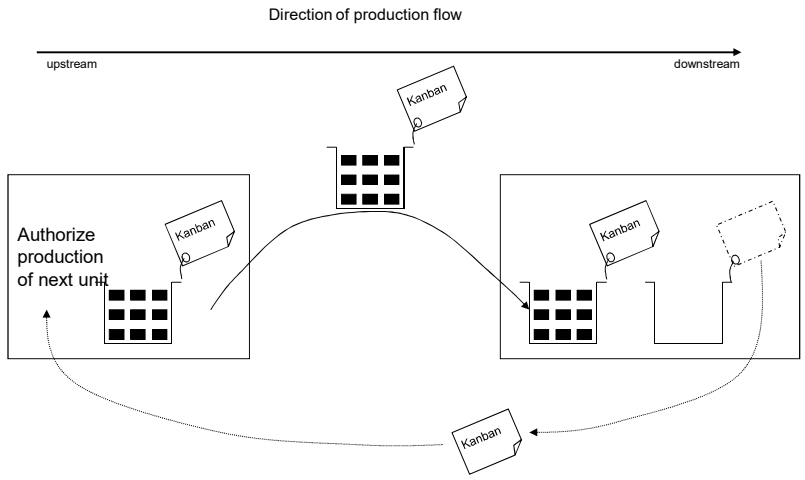
"Push" vs. "Pull"

Push	Production based on forecast – before knowing the actual demand Work is scheduled and *pushed through* each stage in the process *in anticipation* of customer orders
Pull	Production based on actual demand – after seeing the actual demand Work at each stage in the production process is *pulled through* the system *in response to* actual orders for final products / services.

Lean Synchronisation



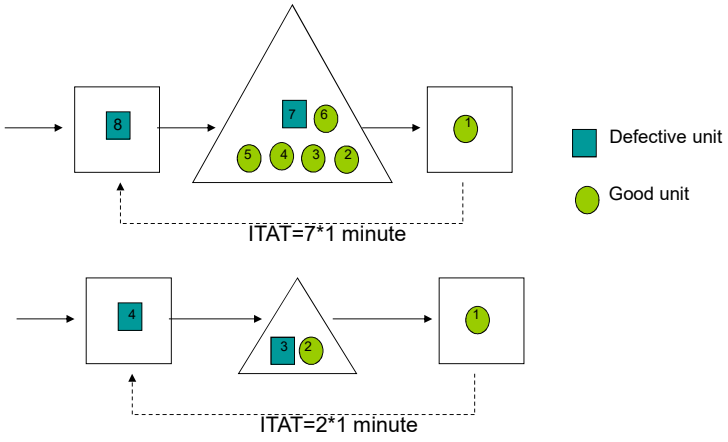
Kanban is a Pull System



Kanban cards also called work authorization forms

Lower Inventory Means Better Quality!

UNIVERSITY OF TRENTO



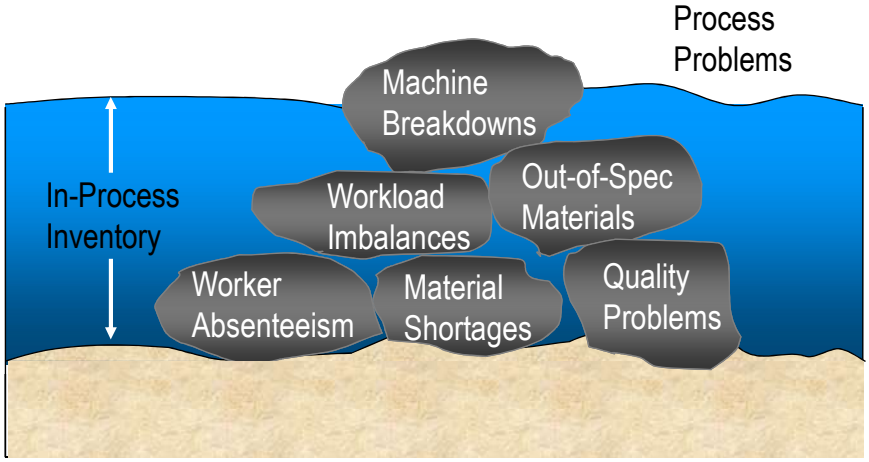
ITAT = Information Turnaround Time

Smaller Buffer Exposes Defects Earlier

Lower Inventory Means Fewer Problems "Rocks in the River" Analogy

UNIVERSITY OF TRENTO

- Water level must be lowered!

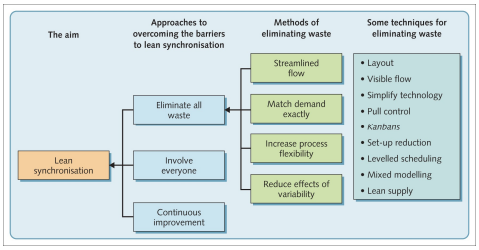


59

Lean Manufacturing

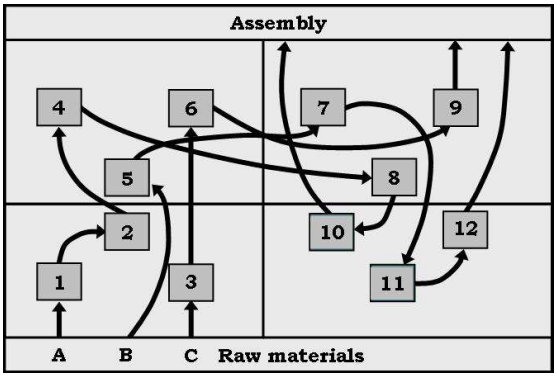
UNIVERSITY OF TRENTO

1. Use of Cellular Layout
2. Demand Pull
3. Level Production
4. Quality at the Source
5. Standardization of Work and Maintenance
6. Use of Safety Capacity
7. Improving Visibility of Performance
8. Employee Involvement
9. Supplier Management



From Process to Cellular Layout

UNIVERSITY OF TRENTO



Part Routing Matrix

UNIVERSITY OF TRENTO

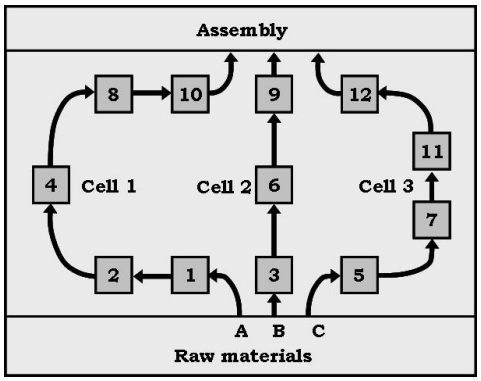
Parts	Machines											
	1	2	3	4	5	6	7	8	9	10	11	12
A	x	x		x				x		x		
B					x		x				x	x
C			x			x			x			
D	x	x		x				x		x		
E				x	x							x
F	x			x				x				
G			x			x			x			x
H							x				x	x

Reordered Routing Matrix

UNIVERSITY OF TRENTO

Parts	Machines											
	1	2	4	8	10	3	6	9	5	7	11	12
A	x	x	x	x	x							
D	x	x	x	x	x							
F	x		x	x								
C						x	x	x				
G						x	x	x				x
B									x	x	x	x
H										x	x	x
E							x		x			x

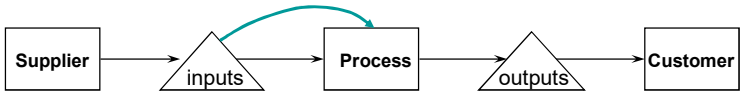
Revised Cellular Layout



2. Demand Pull

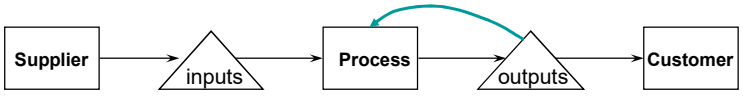
- Material Requirement Planning (MRP)

PUSH: Inputs availability triggers execution

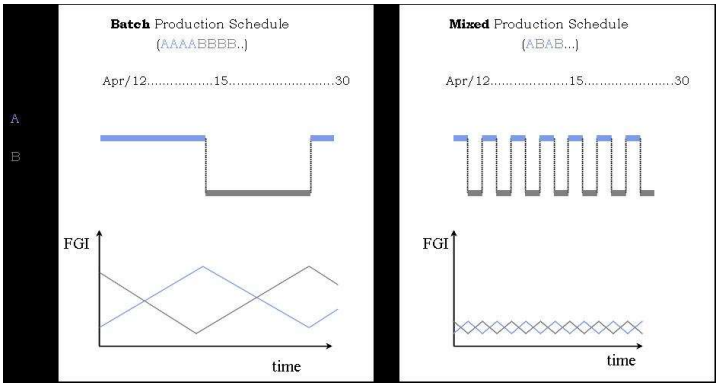


- Kanbans
- Synchronized pull

PULL: Outputs need triggers execution



3. Level Production



4. Quality at the Source

Defects Found at:	Own Process	Next Process	End of Line	Final Inspection	End User's Hand
	$	$	$	$	$
Impact to the Company	• Very Minor	• Minor Delay	• Rework • Resched. of work	• Significant Rework • Delay in Delivery • Additional Inspection	• Warranty costs • Administrative costs • Reputation • Loss of Market Share

5. Standardization of Work and Maintenance

UNIVERSITY OF TRENTO

- **Standardization of Work:**
  - Reduces variability due to changing personnel
  - Reduces variability from one production cycle to the next
  - Makes it easier to identify sources of waste
- **Preventative Maintenance**
- **Poka yoke**

6. Use of Safety Capacity

UNIVERSITY OF TRENTO

Companies that strive for lean manufacturing reduce safety inventory at the expense of increasing safety capacity.

7. Improving Performance Visibility

UNIVERSITY OF TRENTO

- **Understanding performance from the customer's perspective**
  - Close alignment of internal and external measures
- **Understanding of expected and actual performance**

8. Employee Involvement

UNIVERSITY OF TRENTO

- **Expertise**
- **Flexibility**
- **Empowerment**

9. Supplier Management

UNIVERSITY OF TRENTO

- Supplier Selection
- Supplier Development
- Supplier Evaluation