



LEAN SIX SIGMA YELLOW BELT

MakeWay Global is an accredited partner of the International Lean Six Sigma Institute (ILSSI)



About MakeWay Global

MakeWay Global is an international human capital development and management consultancy firm that is **focused on the management of change** for organisations.

Some of our accredited certification courses include:

Business Analysis Diploma	Project/Programme Project Management	Others
Foundation Certificate in Business Change	PRINCE2®	Lean Six Sigma – (White, Yellow, Green, Black Belts)
Business Analysis Practice	AgilePM®	Cyber Security Courses (inc. GDPR, NDPR)
Requirements Engineering	Scrum	Leadership and Management
Commercial Awareness	MSP®	Business Skills (inc Effective Communication)
Modelling Business Processes	MoP®	Business Applications

- World Class Training
- Our Global Associates: are passionate, real world experienced and knowledgeable trainers
- Study at Your Pace
- Post Study Consultation
- Customised Training Solutions (inc specialist areas)
- Exceptional Standards (with Value for Money)

SESSION LOGISTICS



Introductions

Name

**Your current
role**

**L6S awareness
and/or
experience**

**Expectations for
the course**



Yellow Belt Agenda

Day 1

- ❑ Introduction to L6S
- ❑ Some Problem-Solving Methodologies
- ❑ Customers & Value
- ❑ Project Charter
 - Project Definition Tools & Techniques

Day 2

- ❑ Some Tools and Techniques of Lean Six Sigma
 - Introduction to Processes
 - Measurement and Analytical Tools & Techniques
 - Solution Tools & Techniques

Objectives of the Yellow Belt course



To give an understanding of the key principles and concepts of **Lean Six Sigma (L6S)**



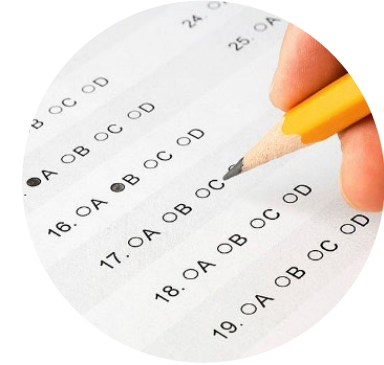
To introduce the basic Lean Six Sigma tools and techniques that become the skills needed to improve workplace efficiency



The importance of recognising process, value and customer, as well as being able to remove waste and create a logical flow



An introduction to the standard frameworks of the DMAIC cycle and other improvement techniques for practical solutions



Understand the importance of continuous improvements and prepare the participants for the Yellow Belt certification



The Yellow Belt Examination & Certification

Complete the exam (pass mark is 70%)

- Online (on laptop or desktop – with Windows or Apple device)
- 50 Questions (multiple choice) – *35/50 to pass*
- 60 minutes duration
- Open book
- Accredited by the International Lean Six Sigma Institute (ILSSI)



Yellow Belt Agenda

Introduction to Lean Six Sigma

- History and Focus for Lean
- History and Focus for Six Sigma
- Lean and Six Sigma – how they complement

Some Problem Solving Methodologies

Customers and Value

Project Charter

Some Lean Six Sigma Tools and Techniques

What is Lean Six Sigma?

A fusion of two related disciplines

Lean

Six Sigma

Both consist of:

Philosophies

Methodologies

Tools and techniques

Lean and Six Sigma are highly complementary

So it makes great sense to combine them

Most practitioners merge the philosophies and combine a subset of the tools into the Six Sigma methodology (**DMAIC**)



The Two Parts of Lean Six Sigma

LEAN	SIX SIGMA
Originated from Toyota	Developed by Motorola
The Toyota Production System (TPS) is at the heart of Lean	Six Sigma equates to 3.4 defects for each million opportunities (DPMO)
The Lean methodology focuses on eliminating waste and smoothing the process flow	To improve processes by reducing variation and defects
Lean is not about cutting costs. It is about removing waste without sacrificing quality	Many (but not all) of the tools are statistical in nature and Six Sigma emphasises taking action based on fact rather than opinion or common belief
People tend to use the term Lean Thinking to describe the culture of Lean	The 'Sigma' (σ) rating of a process can be used as an indicator of how many defective parts a process produces

The Focus of Lean

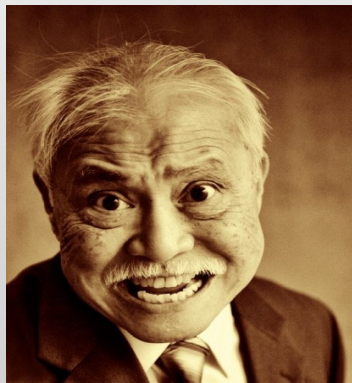
Eighty-five percent of reasons for failure to meet customer expectations are related to deficiencies in systems and process rather than employees. The role of management is to change the process rather than badgering individuals to do better.

- **William Edwards Deming**

American engineer, statistician and professor



All we are trying to do is reduce the time from order to cash



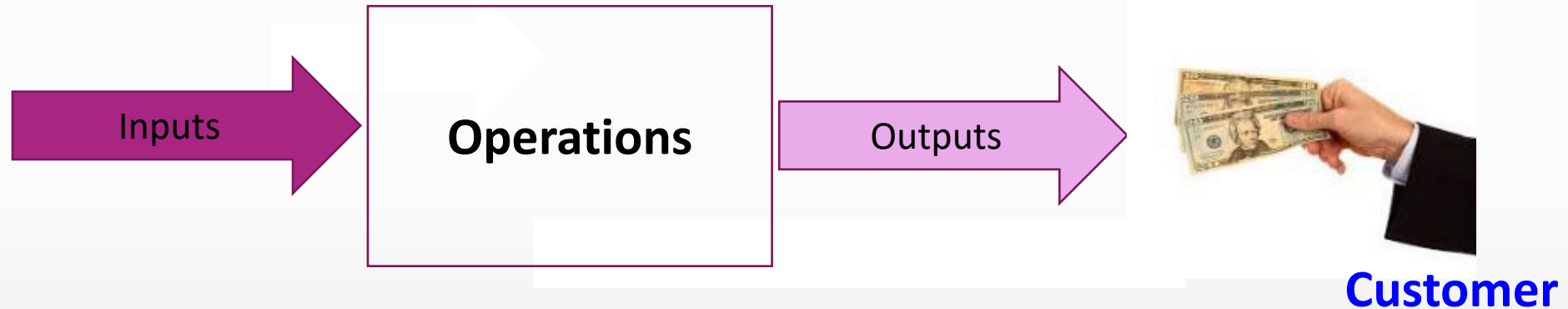
- **Taiichi Ohno**
Toyota Production System

The Focus of Lean

*There are four purposes of process improvement: **easier, better, faster, and cheaper**. These four goals appear in order of priority. Hence, the first is to make the work easier for workers while improving the fruit of their labour.*



**Shigeo
Shingo**



- **Easier** (for the workers)
- **Better Quality** (less defects and rework)
- **Faster** (on time delivery)
- **Cheaper** (lower Cost of production)

The Focus of Lean



Lean is **NOT about cutting costs** it is about removing waste without sacrificing quality. It is the ability to **do more with less** resources.

WASTE is whatever slows the delivery process down

The Toyota Production System (TPS)

MUDA (無駄)
[Waste]

Achieve efficiency

MURA (斑)
[Unevenness/
Irregularity]

Achieve flow

MURI (無理)
[Complexity]

Achieve standardised
work for your tasks

The TPS was created by **Taiichi Ohno** based on the ideas taught by **W Edwards Deming**

Since the late 1980s, the term **LEAN**, which describes the TPS, has been introduced to the western world

Wastes of Lean [Muda] Wastes in Lean Services

Transportation

Inventory (Over)

Motion

Waiting

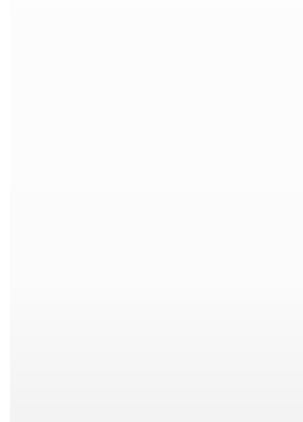
Over-production

Over-Processing

Defects (and Rework)

Skills (unutilised)

TIMWOOD(S)



1) **D**efects

2) **O**ver-production

3) **W**aiting

4) **N**on-Utilised talent (Skills)

5) **T**ransport

6) **I**nventory

7) **M**otion

8) **E**xtra Processing

DOWNTIME

Lean Wastes (Muda) in Services (2)

Defects

- Errors and Rework
- Missing information
- Work not meeting standards
- Ignoring customer requirements

Over-production

- Making more than is needed
- Too many reports, reviews or approvals
- Excessive documentation
- Documents carrying the same information
- Batching paperwork

Waiting

- Waiting for information or paperwork
- Waiting for approval
- Equipment downtime
- Waiting time between batch processing
- Delays

DOWNTIME

Lean Wastes (Muda) in Services (3)

Non-utilised Skills

- Not utilising the skills and the knowledge of those who work for the organisation
- Not listening to a good idea
- Unclear communication – such as leaving people to guess what is required

Transportation

- Paper-based rather than electronic
- Unnecessary electronic transfer – why are some people cc'd for every email discussion that they do not need to know about
- Data travels to multiple locations
- Inefficient inter-office mail system

DOWNTIME



Lean Wastes (Muda) in Services (4)

Inventory

- Excessive backlog or work in progress
- Creation of queues
- More than the absolute minimum being stored (paper and electronic)
- Partially completed work

Motion

- Walking to deliver paperwork
- Chasing needed information or paperwork
- Lack of *ergonomic workspace or design
- Task switching

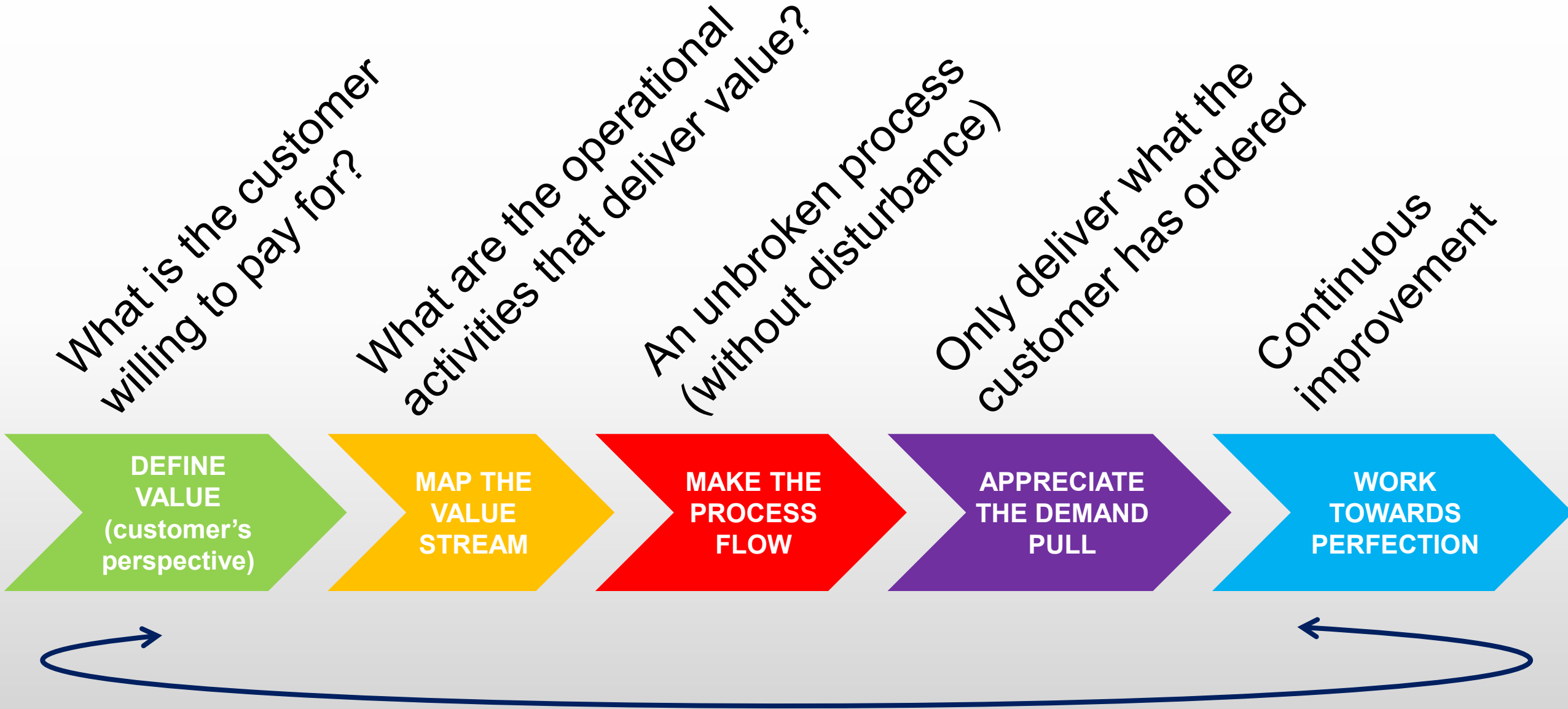
Extra processing

- Unnecessary steps
- Multiple handoffs
- Multiple documents
- Lack of standard procedure
- Excessive checking
- Re-learning
- Extra features and complexity

DOWNTIME

*Process of designing or arranging workplaces, products and systems so that they fit the people who use them

The Five Principles of Lean



Single Piece Flow

In *Single Piece Flow*, products or transactions are handled in batches of **ONE**

Each item is examined for defects before handing over (to next part of process)

Faulty units are **avoided** being passed downstream (i.e. towards the customer)
→ Production halts until the problem is rectified)

In practice, it often means working to the smallest batch size possible



TRADITIONAL BATCH SYSTEM



ONE-PIECE FLOW SYSTEM

Pull

In *Pull* systems, material flow is triggered by downstream demand

Example:

- A user replaces the printer toner from the department's stationery cupboard (and leaves a Kanban for the store)
- The store replenishes the stationery cupboard (and leaves a Kanban for procurement)
- The procurement team places an order with the supplier to replenish the warehouse
- The supplier replaces the toner in the warehouse

So the flow is triggered by the customer placing an order – you can see how *Single Piece Flow* links in. This keeps stock holding to a minimum, thus reducing waste. Only that which is used is replaced!

Pull is the opposite of 'Push'
– where regular deliveries are driven by a schedule

What are Kanbans?

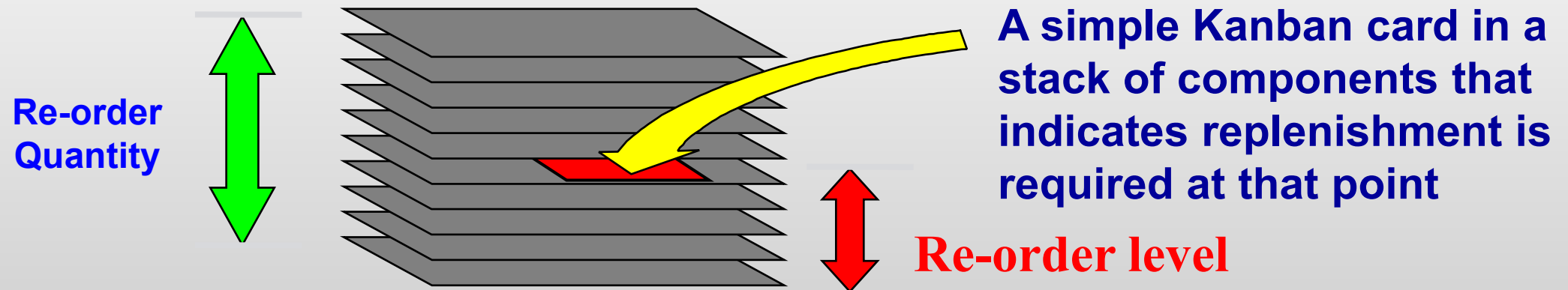
A Kanban can be a whole host of things:

- a card
- a bin, container or pallet
- an empty square
- a ping pong ball or tennis ball
- a token etc.



Visual Signals

The Kanban has a particular purpose – it acts as an indicator for stock control and replenishment based on pre-set, fixed re-order levels and re-order quantities for materials. It is a short term execution tool



The Six Sigma Approach

Six Sigma is a management ideology, whereby business process improvements are based on statistical analyses and predictions.

What is the reason behind calculating the sigma value?

The value in making a sigma calculation is that it abstracts your level of quality enough so that you can compare levels of quality across different fields (and different distributions)

In other words, the sigma value (or even DPMO) is a universal metric that can help anyone with the industry benchmark/competitors

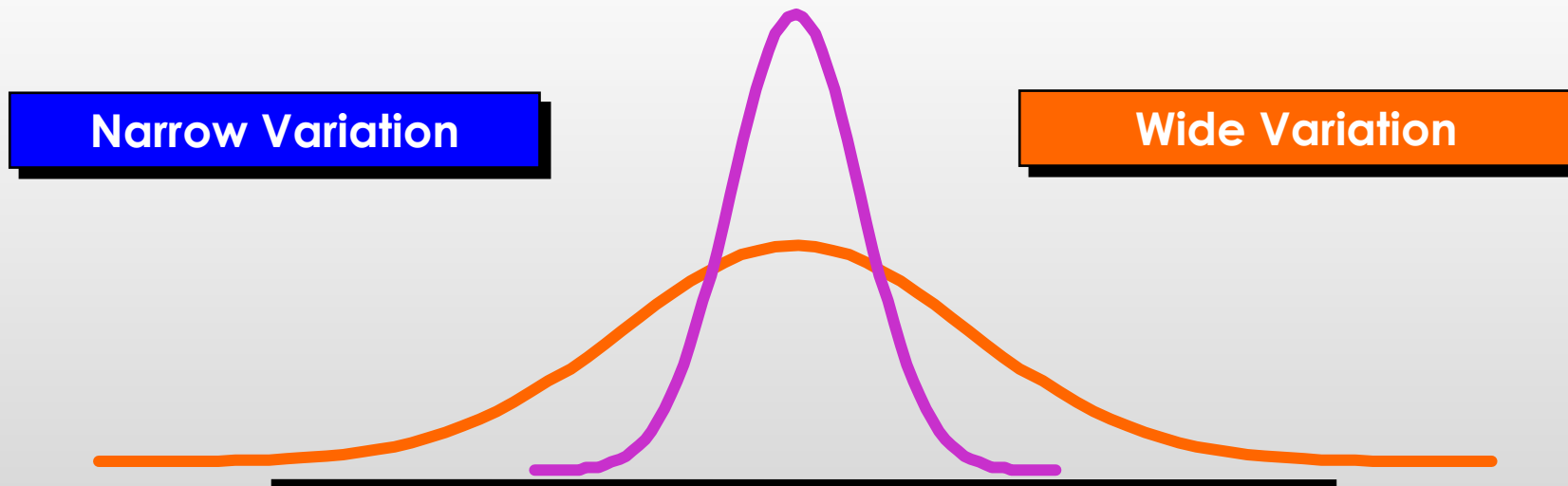
Basically, a business process that churns out less than 3.4 defects per million opportunities is considered to be six sigma efficient, and thereby determines **QUALITY!**

What is the Six Sigma Symbol?

σ , Sigma, is the 18th letter of the Greek alphabet

Mathematicians use this symbol to signify Standard Deviation, an important measure of variation

Variation designates the distribution or spread about the average of any process

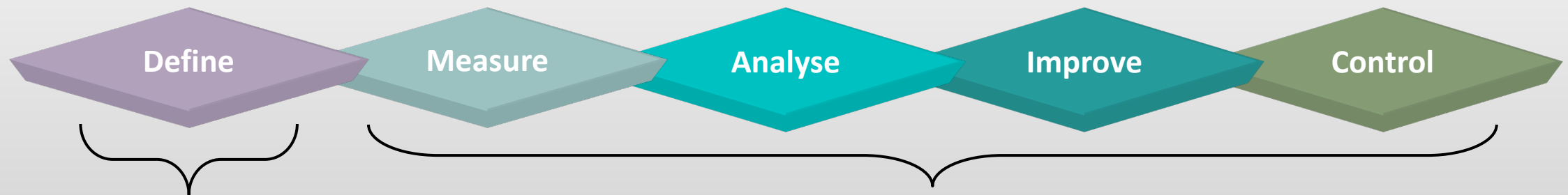


History of Six Sigma

Six Sigma created a realistic and quantifiable goal in terms of its target of **3.4 defects per million operations/steps** – this indicates that 99.99966% of its products or services are without flaws.

It was also accompanied by problem-solving strategy made up of four steps:
Measure, Analyse, Improve and Control

When GE launched Six Sigma, they improved the methodology to include the **Define** phase

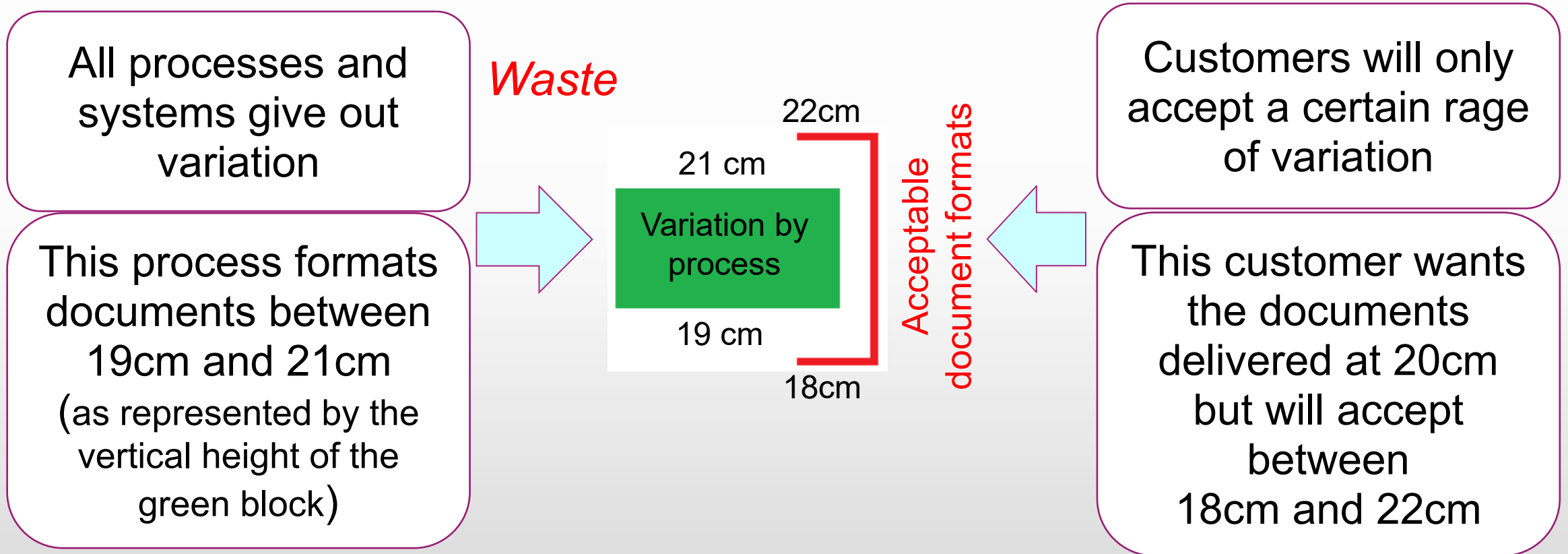


GENERAL ELECTRIC

MOTOROLA

The Focus of Six Sigma

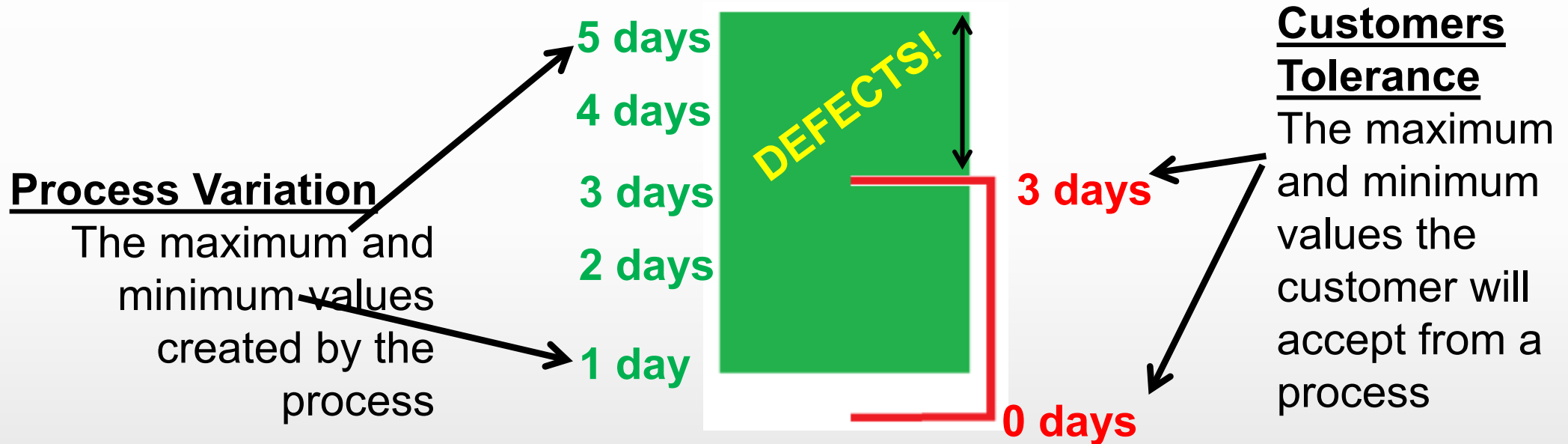
To reduce variation and avoid giving the customer defective products



Waste is whatever gives rise to unacceptable deviation (defects)

Defects

Anything produced greater or smaller than the customer specifications (i.e. outside their tolerance)



Example: Customers expect a response to a question within three days. When measured the company responded to all questions within 1-5 days. This is therefore **NOT** a **capable** process

How they Complement Each Other

Six Sigma helps Lean because...

Lean does not really have a formal project methodology, whereas Six Sigma has DMAIC.

DMAIC allows the improvement team to have a clear set of activities for the **Measurement** and **Analyse** phases.

Lean does not consider the problems with variation; however, Six Sigma adds statistical modelling tools to track down and investigate variation.

Lean helps Six Sigma because...

Lean provides alternatives to DMAIC for less complex improvement areas.

For example, Kaizen events can be performed frequently by everyone.

Lean focuses on waste and end-to-end flow. Lean defines waste from the customer's perspective. By itself, Six Sigma may take an insular view, optimising a process to meet a local target. Process sigma levels are reached more rapidly by also considering waste

Key Principles of Lean Six Sigma

1 – Customer focus

Focus on the Customer (VoC) first; not the business process

2 – Know the value stream

Identify and understand how the work gets done (the value stream)

3 – Business Process

Manage, improve and smoothen the process flow
→ Identify and eradicate waste wherever possible

4 – Manage by facts and data

→ Not by opinion
→ Identify and understand how the work gets done and not how you think it gets done
→ Reduce variation

5 – Trust and empower people

→ Those closest to the work are usually the true Subject Matter Experts (SMEs)
→ Empowerment must be resourced
→ Transparency (is two-way)

6 – Drive for perfection

Improve processes systematically

The Costs of Lean Six Sigma

Both Lean and Six Sigma are license and royalty free

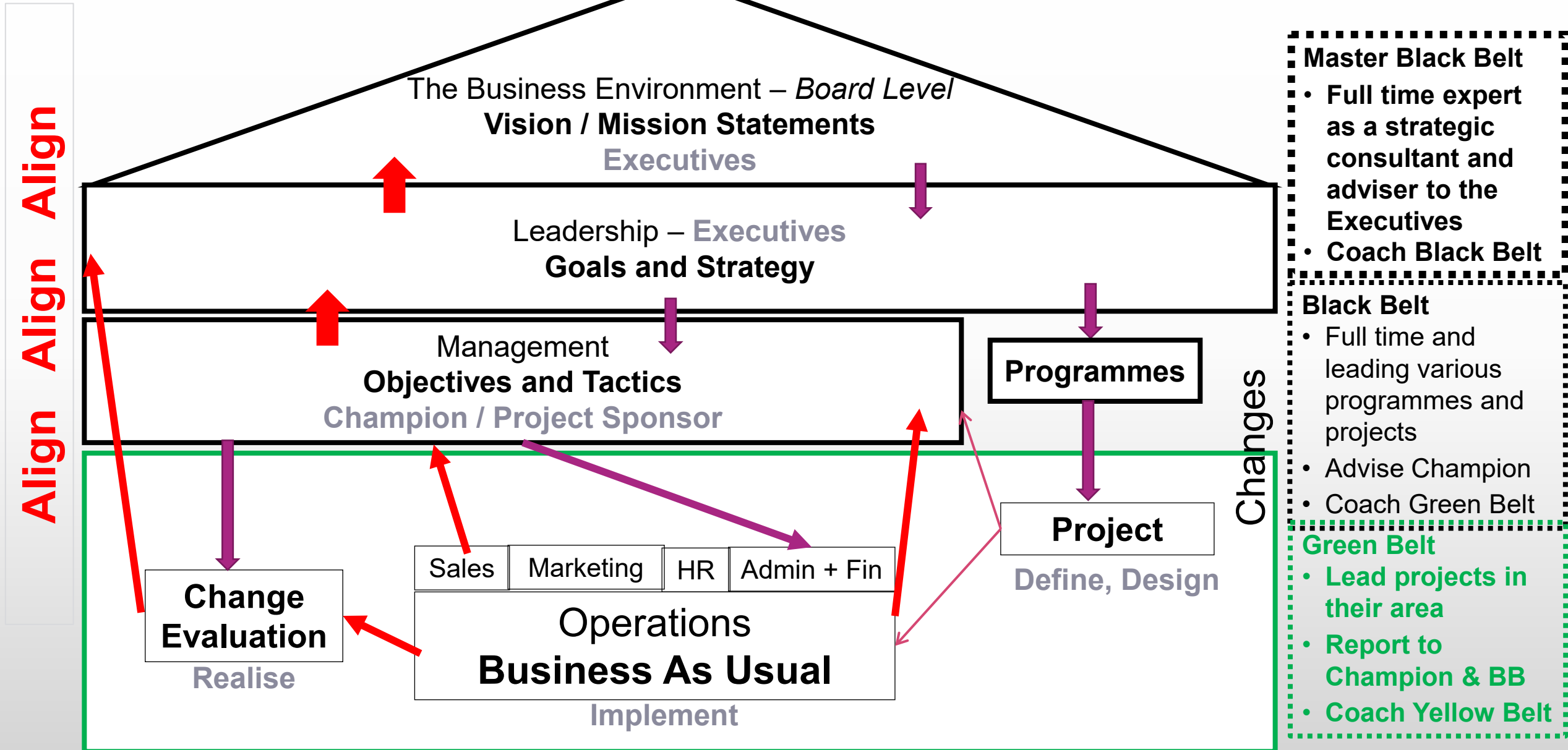
But there are costs:

Training

Co-ordination and culture change

Also, if people are spending time improving a process they are not serving customers etc

The Lean Six Sigma Framework



Lean Six Sigma – Yellow Belt

Yellow Belts are Workers and Functional Specialists and apply the Lean Six Sigma Methodology to their own work and serve on project teams on a part-time basis.

- Understand the terminology and overall Lean Six Sigma process
- Awareness of the major tools and techniques embraced by Lean Six Sigma
- Understand the underlying philosophy of *Lean* and *Six Sigma*
- Acts as a team member under the direction of a Green Belt or Black Belt holder



Yellow Belt Agenda

Introduction to Lean Six Sigma



Some Problem Solving Methodologies

- 3Cs / 8Ds
- PDCA / PDSA
- Kaizen
- DMAIC / DFSS

Customers and Value

Project Charter

Some Lean Six Sigma Tools and Techniques

Introduction to Problem Solving Methodologies

Context	No problem, but an idea	Immediate problem	Simple problem requiring agreement	Problem requiring some analysis	Complex issues	Problem requires a new process and may involve strategic investment
Action	I have an idea	I know what I need to do quickly with little cost or changes	A simple problem for which an improvement is proposed	Jointly with people who work within the department or process	This is a project that requires a tooled methodology	This issue requires investment in a new product, service or process
Execution: Duration / No. of People	1 hour - 1 week	1 hour - 1 week	1 - 4 weeks	1 - 3 months	3 - 6 months	6 months - 3 years
	1 person	1 person	The team	3 - 7 people	4 - 10 people	> 20 people
Tools	Idea Management System	3C	8D / Kaizen / PDCA/PDSA	Kaizen	DMAIC	DMADV (DFSS)
Lean			Six Sigma & Lean Six Sigma			

3 Cs

Concern

- Identify and articulate what the problem is
- What needs to be addressed?
- e.g. Why are hotel bookings for missions delayed as at the time of arrival of staff?

Cause

- Identify what the root cause is
- Identify the best solution
- e.g. Staff do not submit required data with the requests to protocol

Correct (counter-measure)

- Implement the selected solution
- Maintain the implementation
- e.g. Design and enforce automated forms that ensures accurate data are collected

The 8 D's (*Eight Disciplines*)

D0

Prepare to solve the problem

D1

Establish the Team

D2

Describe the problem

D3

Develop an Interim Containment Action (band aid)

D4

Define/ Verify Root Cause

D5

Choose / Verify Permanent Corrective Action

D6

Implement / Validate Permanent Corrective Action

D7

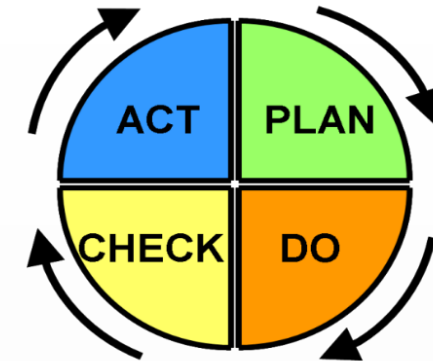
Prevent Recurrence

D8

Recognise and praise the Team

Developed at the Ford Motor Company, its purpose is to identify, correct and eliminate recurring problems so as to get a permanent resolution. These disciplines are performed within a control structure (for example you may perform D5 within the DMAIC Improve phase)

The PDCA Steps



Plan

- Develop a plan to address a problem or hypotheses
- Identify control points and control parameters
- The plan is reviewed and agreed

Act

- The results are analysed
- The causes of any differences between expected and actual results are identified, discussed and agreed
- If necessary, corrective action is identified which triggers another cycle (Plan)

Do

- The plan is carried out – implement the solution to the problem

Check (or Study)

- Information is collected on the control parameters
- The actual results are compared to what was expected

CHECK – did we achieve what was expected?

STUDY – what can be learnt from what was achieved to provide further help?

PDSA

Plan

Do

Study

Act

Kaizen

Kai + Zen (Continuous Improvement)



A philosophy of small improvements that involves any level of employees from top management to the lower cadre. The culture is driven so that area or people can be considered.



Individual philosophy:
Everyone is encouraged to come up with small improvement suggestions on a regular basis



Kaizen is based on making little changes on a regular basis and not major changes. The emphasis is to always improve productivity, safety and effectiveness while reducing waste

An umbrella term covering several areas typically:

- An individual philosophy
- A team based improvement methodology (Kaizen Event / Kaizen Blitz)

Creating a Kaizen

1 month



Preparation

- Management team identify areas of waste in the process, identify resources needed to fix them and prioritise remedial actions (Kaizen Bursts)

0 – 2 days



Pre Kaizen

- Optional – only used in longer Kaizen Bursts

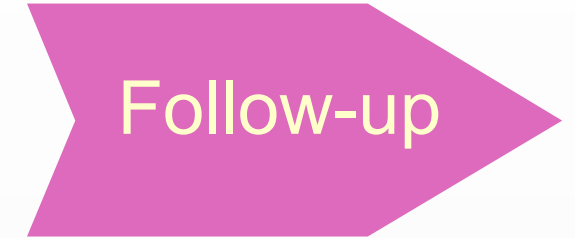
2 – 5 days



Implementation

- This is the Kaizen Event
- Solution Team work full-time on the problem

1 month



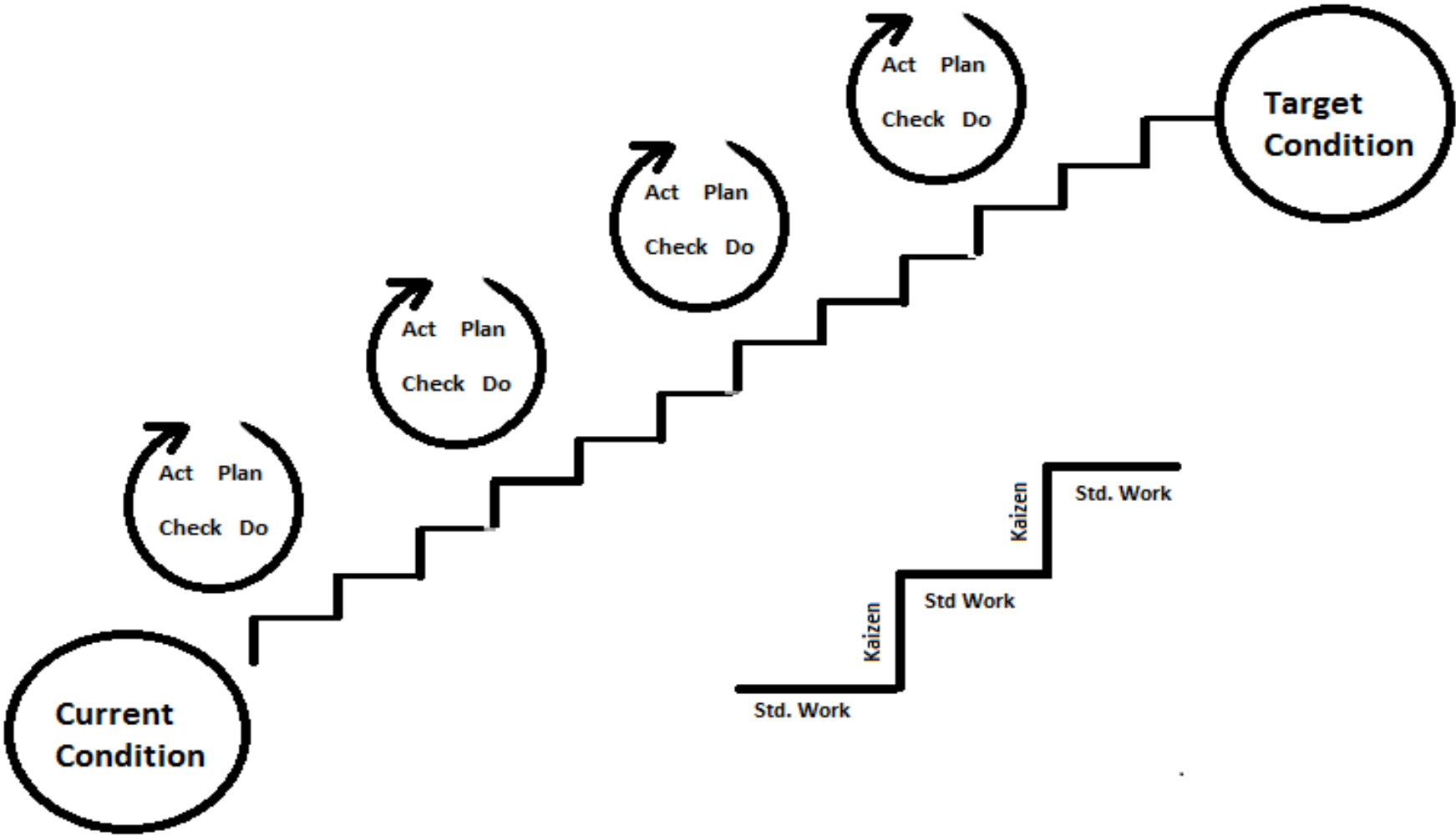
Follow-up

- Optional – used in longer Kaizens or where the solution cannot be completed within the timeframe of the Kaizen Burst

Kaizen is not suitable

when rigorous statistical analysis and data gathering needed

Continuous Improvement (Kaizen)



5-Day Kaizen Burst: An Example

Day 1 and 2 (Plan)

Kick-off (executive presence)
Analyse current state
Perform root cause analysis
Design future state
Interim briefing

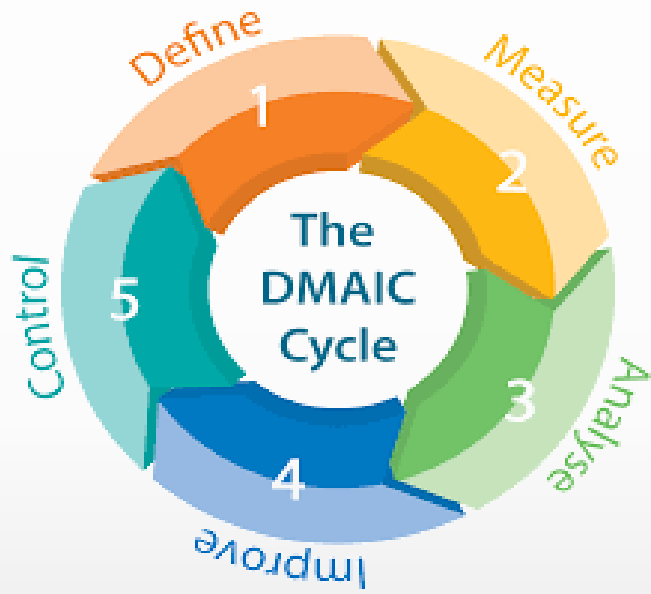
Day 3 and 4 (Do, Check)

Design and test improvements
Obtain buy-in
Interim briefing

Day 5 (Check, Act)

Finalise improvements
Train process workers and stakeholders
Present results
CELEBRATE!

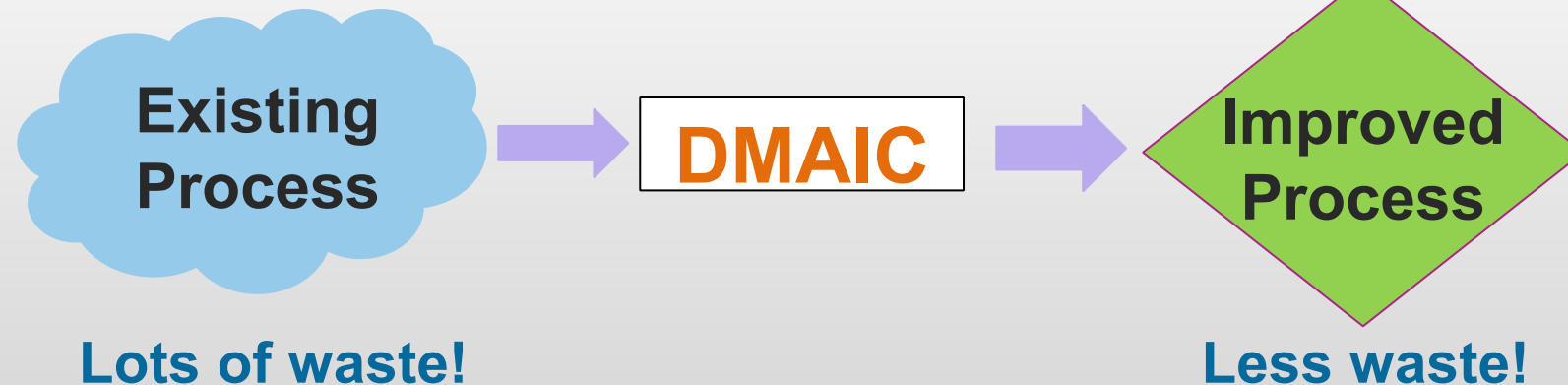
DMAIC – a logical flow to problem solving



A 5-step methodology that provides a structured framework to improve an **existing** process

The DMAIC framework helps ensure that improvement projects:

- Are clearly defined
- Are clearly implemented
- Have their results embedded in standard operations



Lots of waste!

Less waste!

A View of the DMAIC Phases

DEFINE

- Establish the project (get the team together and agree governance)
- Define the problem (Set the scope of the project)
- Talk to Customers and seek to understand their needs from the processes under investigation

MEASURE

- Collect data about the process being investigated
 - Create a Data Collection Plan and Data Collection Forms
- Illustrate how the process is now ('As Is')

ANALYSE

- Analyse the data (probably using statistical tools)
- Determine genuine areas of waste and their root causes
- Illustrate how an improved process would look ('To Be')

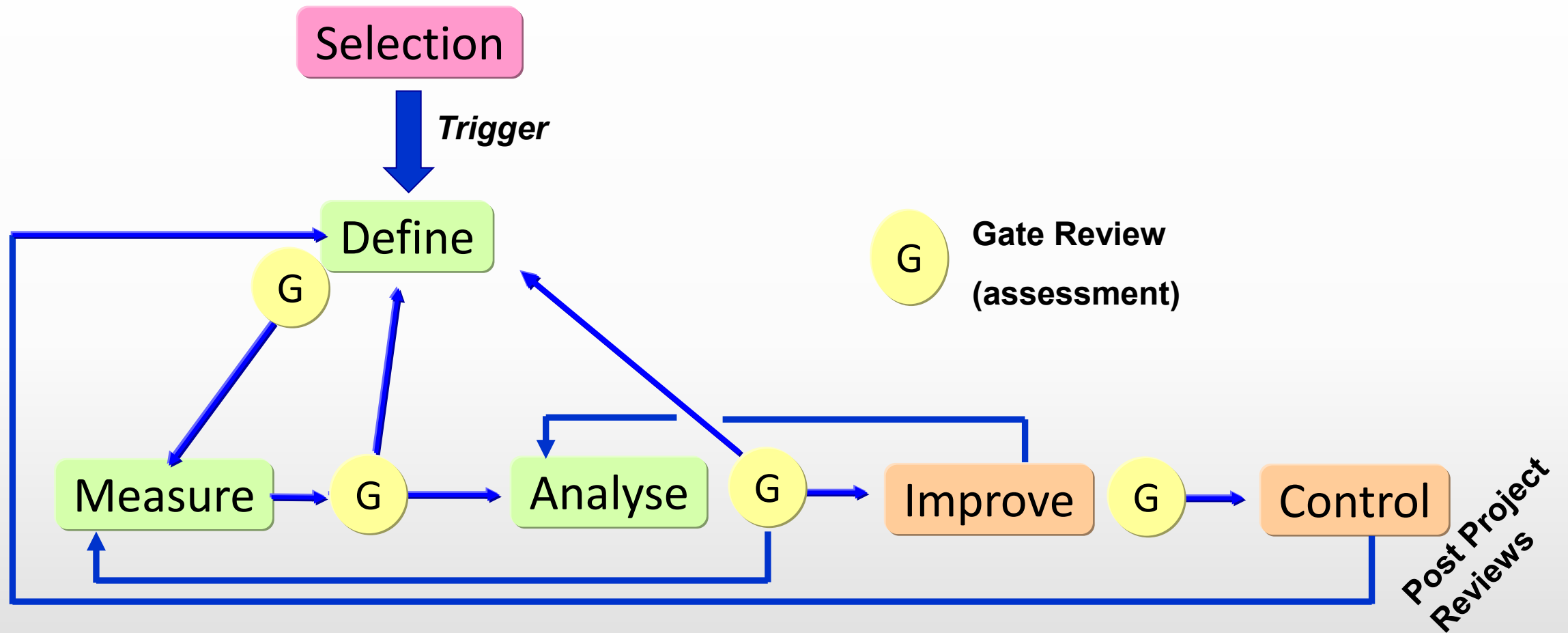
IMPROVE

- Select, trial and implement solutions
- Create a Control Plan

CONTROL

- Close the improvement project
- 'Sustain the change' – monitor the improved process (if performance degrades, this triggers corrective action)

DMAIC is not necessarily a straight sequence



Questions to Answer at a Review

Is the project still likely to deliver a worthwhile result?

Is it forecast to end on time?

- If not what is the new projection?

Is the cost forecast still ok?

What is the updated status of the business risk?

What other significant risk is there?

How are these risks being handled?

Any barriers to successful conclusion – particularly political ones?

How is the team getting on?
What are the next steps?

Schedule 15-90 mins for this (keep the meeting lean and light)

Avoid meeting overrun

Some people use power point slides and either present them or e-mail them out

Gateways / End term assessments

It is sensible to review a project from time to time to see if all is well and if it should continue

- Often called 'Tolls', 'Tollgates', 'Gates' or 'Gateway' reviews
- A logical place for this in DMAIC is at the end of each phase

At this time those running the project should discuss the state of the project with the sponsors of the project

If you are running the project as a GB then your sponsors are likely to be your local champion and perhaps your manager and also your Black Belt

DFSS: Design For Six Sigma

Six Sigma is a process **improvement** methodology

DFSS is not as widely embraced as Six Sigma but still very popular

The most common methodology quoted for DFSS is DMADV

DFSS is complimentary as it is **focused on designing new products/services to Six Sigma quality** levels instead of improving something already in existence


DFSS is a framework which describes what a methodology needs to do to create high quality processes from scratch

DMADV

Define
Measure
Analyse
Design
Verify



KNOWLEDGE TEST

- What was the name of the first company to use the name 'SIX SIGMA' to describe its Quality Management System.
- What is the first principle of Lean; the most important thing that a Lean process must provide for the customer?

- Which Japanese company is considered as being the first to use true 'Lean Production' effectively and successfully?
- A basic principle of Six Sigma is to always find the true original source of a defect or problem. This is called _____?
- A "Six Sigma Process" is often described one that produces no more than 3.4 DPMO. What does DPMO stand for?

Yellow Belt Agenda

Introduction to Lean Six Sigma



Some Problem Solving Methodologies



Customers and Value

- Who are Customers, and what they want
- Affinity Diagrams
- The Kano Model
- Critical to Quality

Project Charter

Some Lean Six Sigma Tools and Techniques

What are Customers?

Consume outputs from a process

Can be *internal* or *external*

Customer's needs often referred to as VoC (Voice of Customer)

Business also has a voice – VoB (Voice of Business)

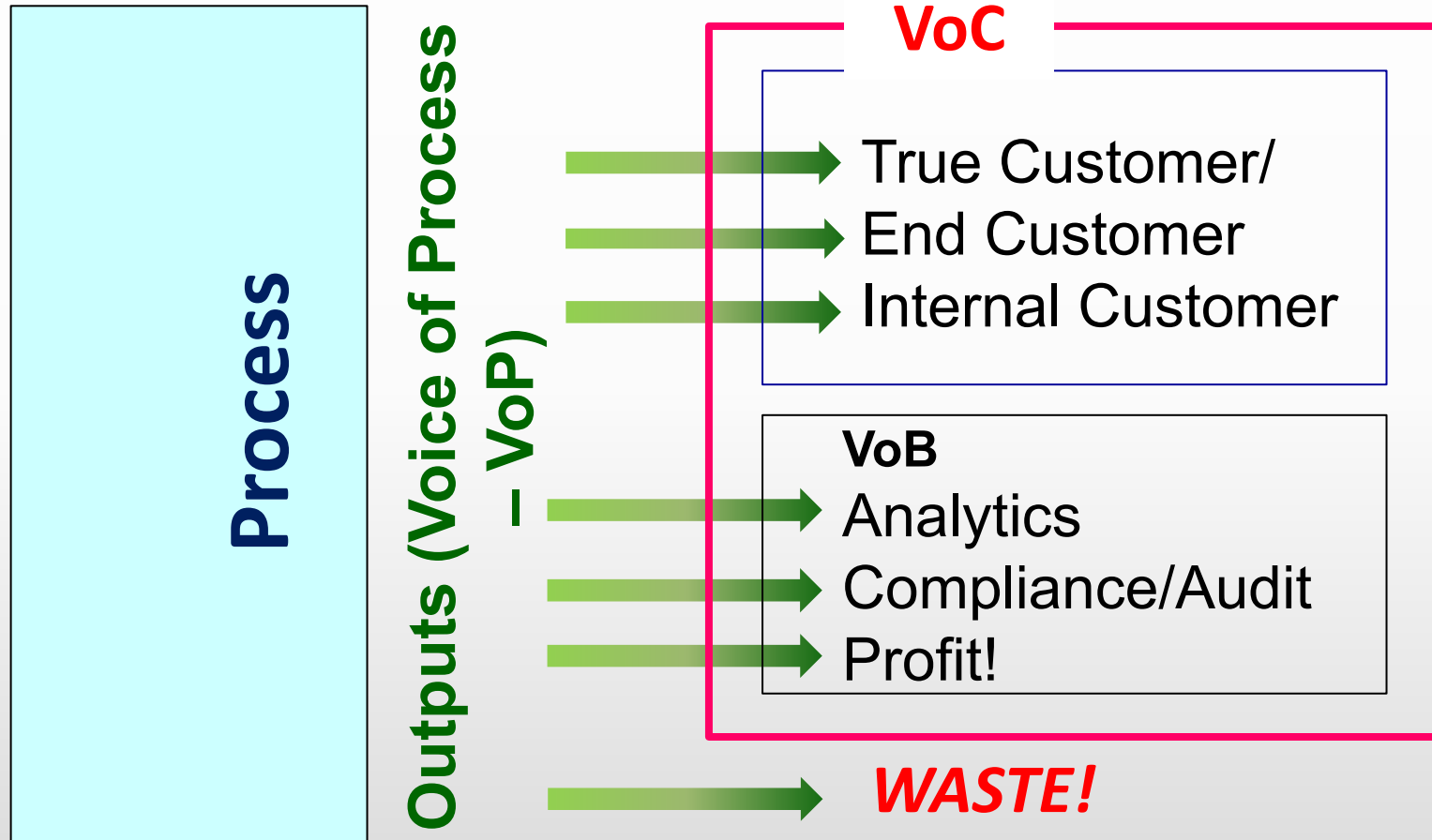
Both VoB and VoC consume outputs from a process

Sometimes convenient to think of Business as 'just another customer'

Sometimes convenient to think of VoB and VoC as conflicting

We refer to the outputs from a process as the VoP (Voice of the Process)

Who wants the Outputs?



A customer takes an output from a process. This can be either 'proper' customers, downstream colleagues, business intelligence or regulatory compliance etc.

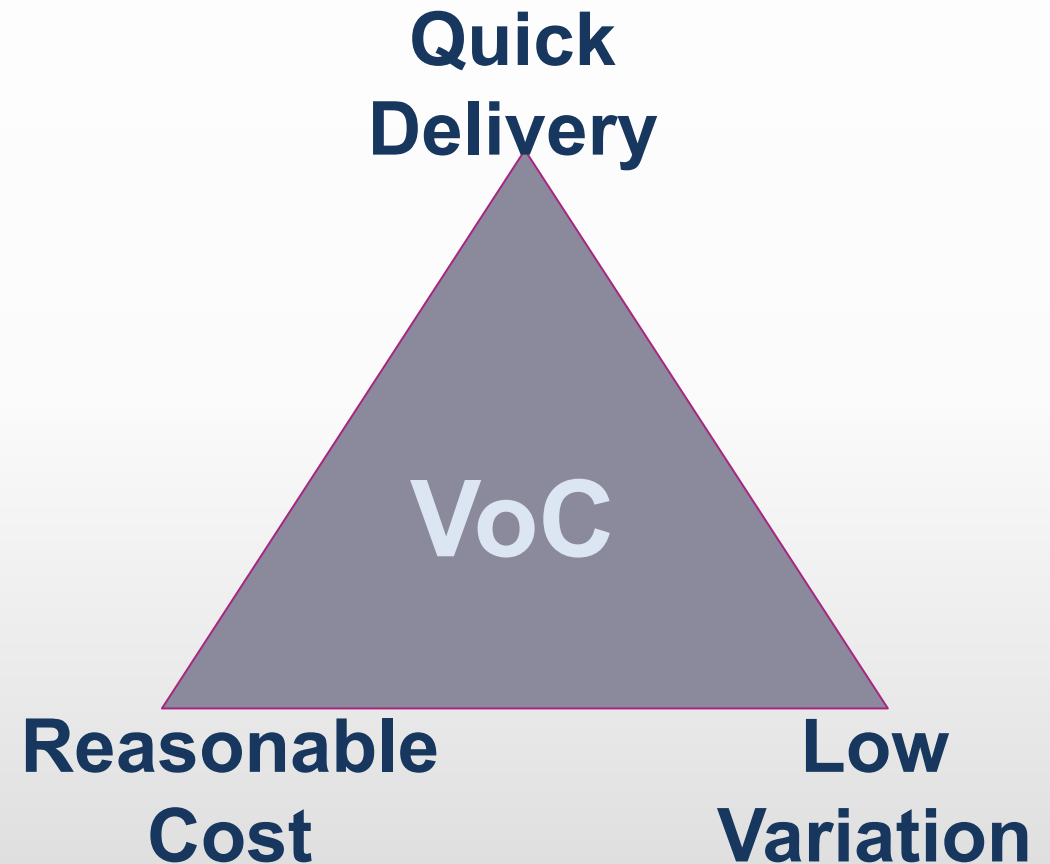
Making Customers Happy

Customers want **three things** from a product or service:

- Minimum variation
- Quick delivery (short lead time)
- Reasonable Cost

These three requirements are linked together and need to be balanced out.

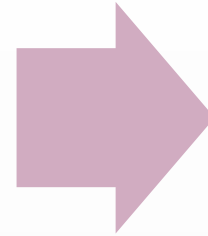
The Voice of the Customer (VoC) tells us what this balance should be.



What do we mean by Value?

A customer is willing to pay for it

- This can be VoC or VoB



A feature that a customer finds worthwhile or useful

- But they need to be able to afford it

Value is often categorised as follows:

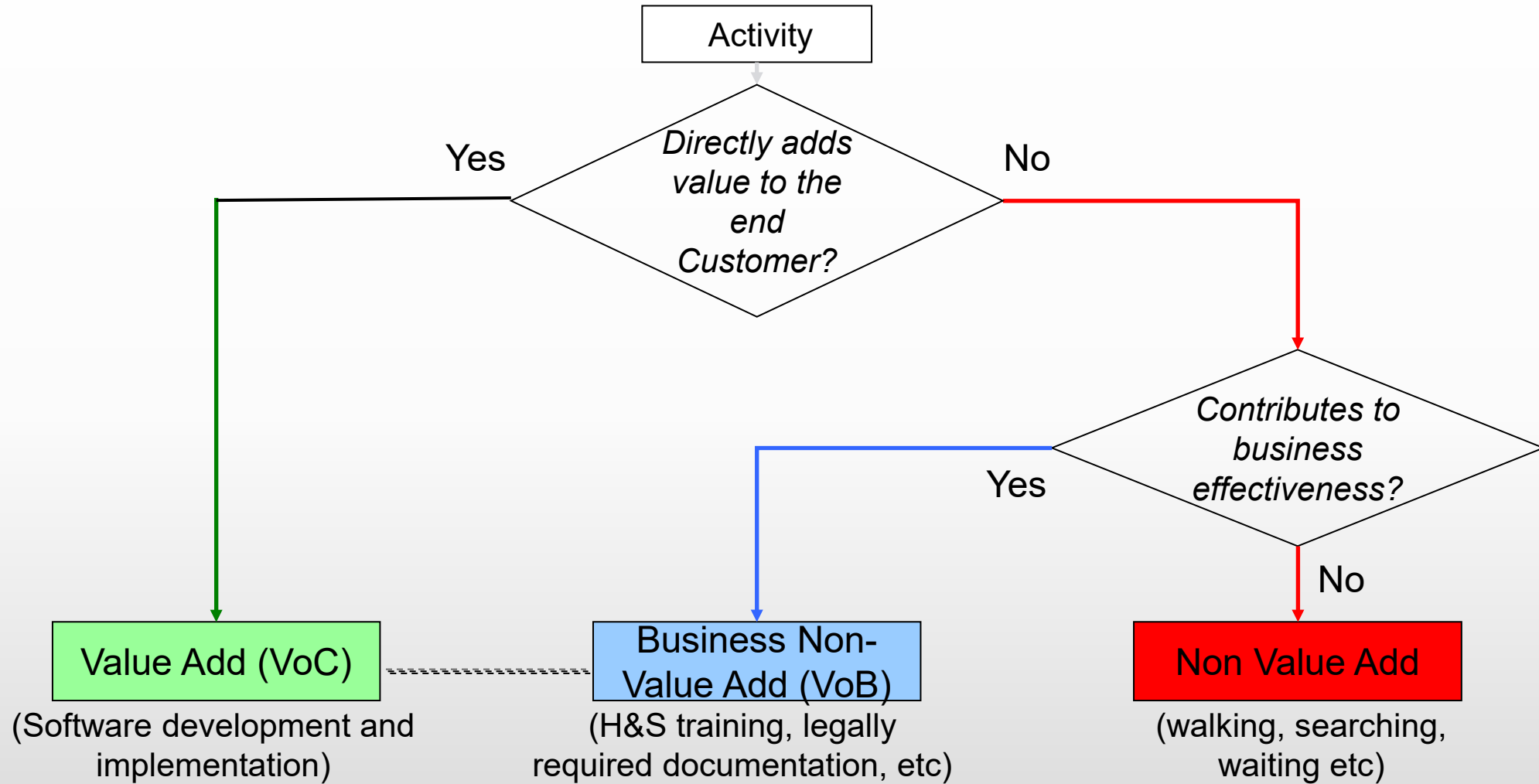
Value term	What it means
Value Added (VA)	This feature, task, process step or output is worthwhile in the view of the customer and they would be willing to pay for it
Business Non-Value Added (BNVA)	This feature, task, process step or output is worthwhile in the view of the Business (it is necessary in some way to run efficiently or legally etc), but it does not directly add value in the eyes of the customer
Non Value Added (NVA) [Waste]	Neither Business nor Customer judges this feature or task or output as worthwhile

Maximise it!

Minimise it!

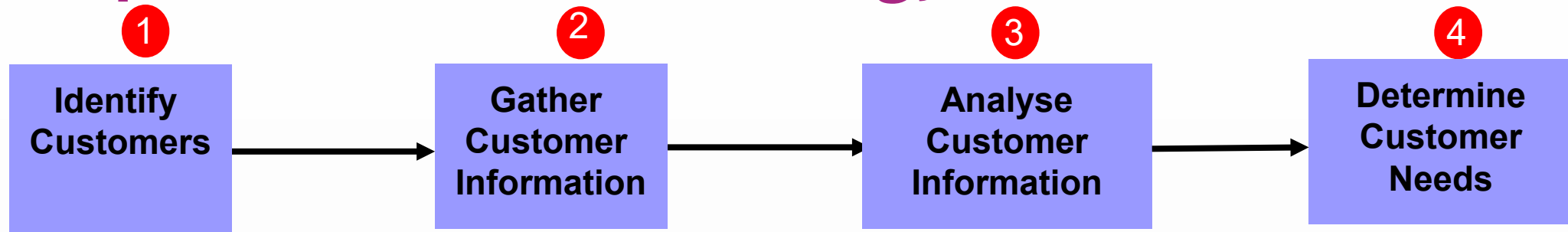
Remove it!

The Path to Value



The key question to always ask is 'Would my customer pay for this?'

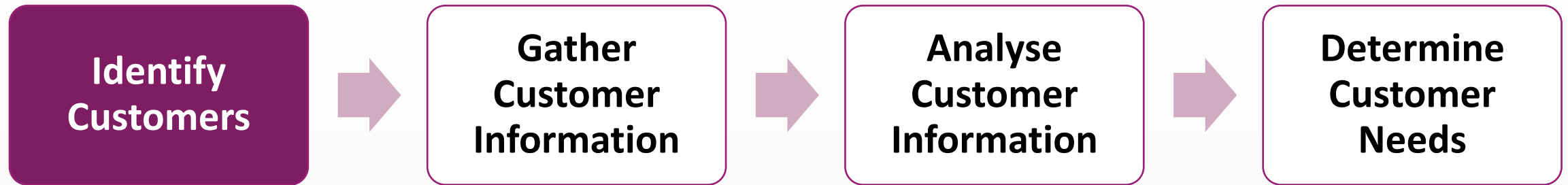
4 Steps of the VoC Methodology with Associated Tools



Tools

<ul style="list-style-type: none"> Customer Segmentation 	<ul style="list-style-type: none"> Listen to people Observe their actions 	<ul style="list-style-type: none"> Affinity Diagram KANO 	<ul style="list-style-type: none"> CCR/CTQ/CTS Requirements
<p>Step 1: Developing customer-focused business strategy <i>To develop a customer-focused business strategy requires:</i></p> <ul style="list-style-type: none"> An assessment of the business needs The identification of customer segments 	<p>Step 2: Listening to the VoC <i>To obtain useful and valid customer information and feedback requires:</i></p> <ul style="list-style-type: none"> Selecting research methods to gather customer information Probing for complete understanding 	<p>Step 3: Translating VoC to CCRs <i>Translating the VoC into Critical Customer Requirements (CCRs) requires:</i></p> <ul style="list-style-type: none"> Organising and verifying customer needs data into CCRs Determining CCR priorities Identifying CCR measurement and targets 	<p>Step 4: Developing Measures and Indicators <i>Translating the CCRs into input, process and output indicators requires:</i></p> <ul style="list-style-type: none"> Identifying and selecting output indicators Establishing targets Determining process characteristics <p>CTQ=Critical to Quality CTS=Critical to Satisfaction</p>

VoC Step 1: Identify Customers



Tools:

Customer Segmentation

Customer Archetype



Customer Segmentation

It is rare to have only one customer: each has their own voice



Interest area?

- Business, Consumer, compliance, etc.

Age?

Background?

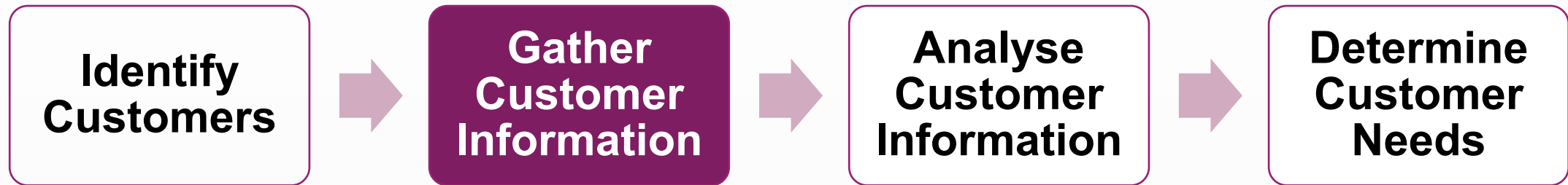
Criticality of supply?

Frequent / heavy user?

Casual / contractual

Customer Segmentation is splitting customers into groups according to different needs, behaviours etc...

VoC Step 2: Gather Customer Information



Objectives:

- Identify and acquire relevant, topical and accurate information about the customer

Tools:

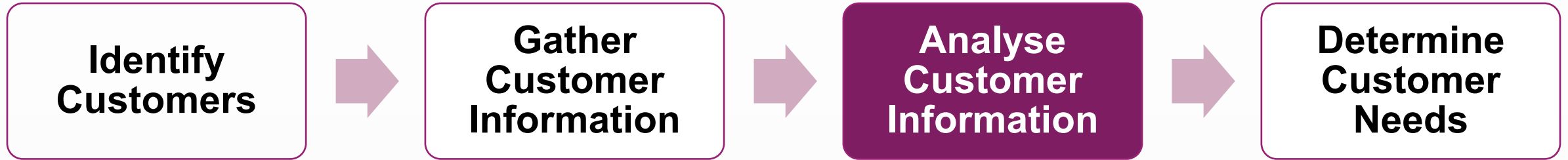
- Observation
- Customer information sources



Example of customer information sources



VoC Step 3: Analyse customer information



Objectives:

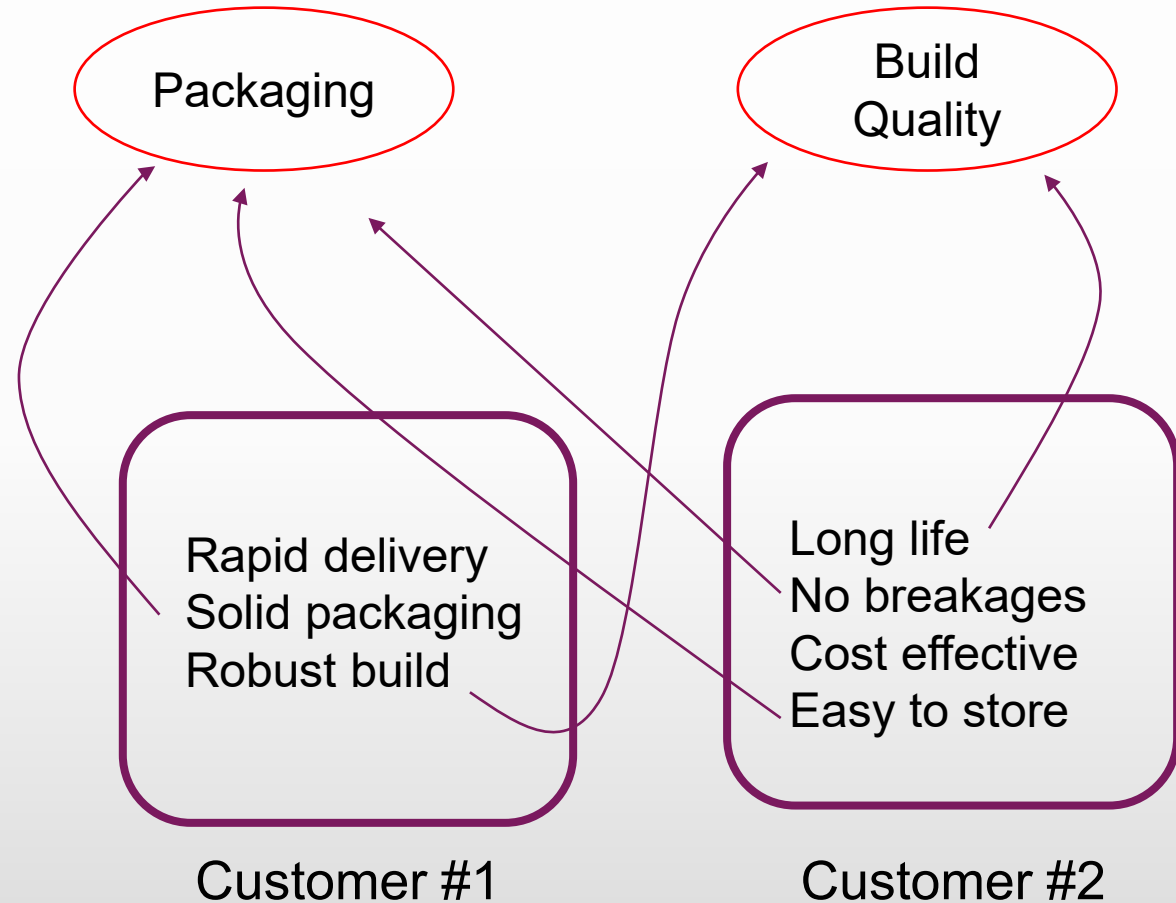
- Generate a list of key customer needs in *their* language
- Organise customer information
- Prioritise customer needs

Tools:

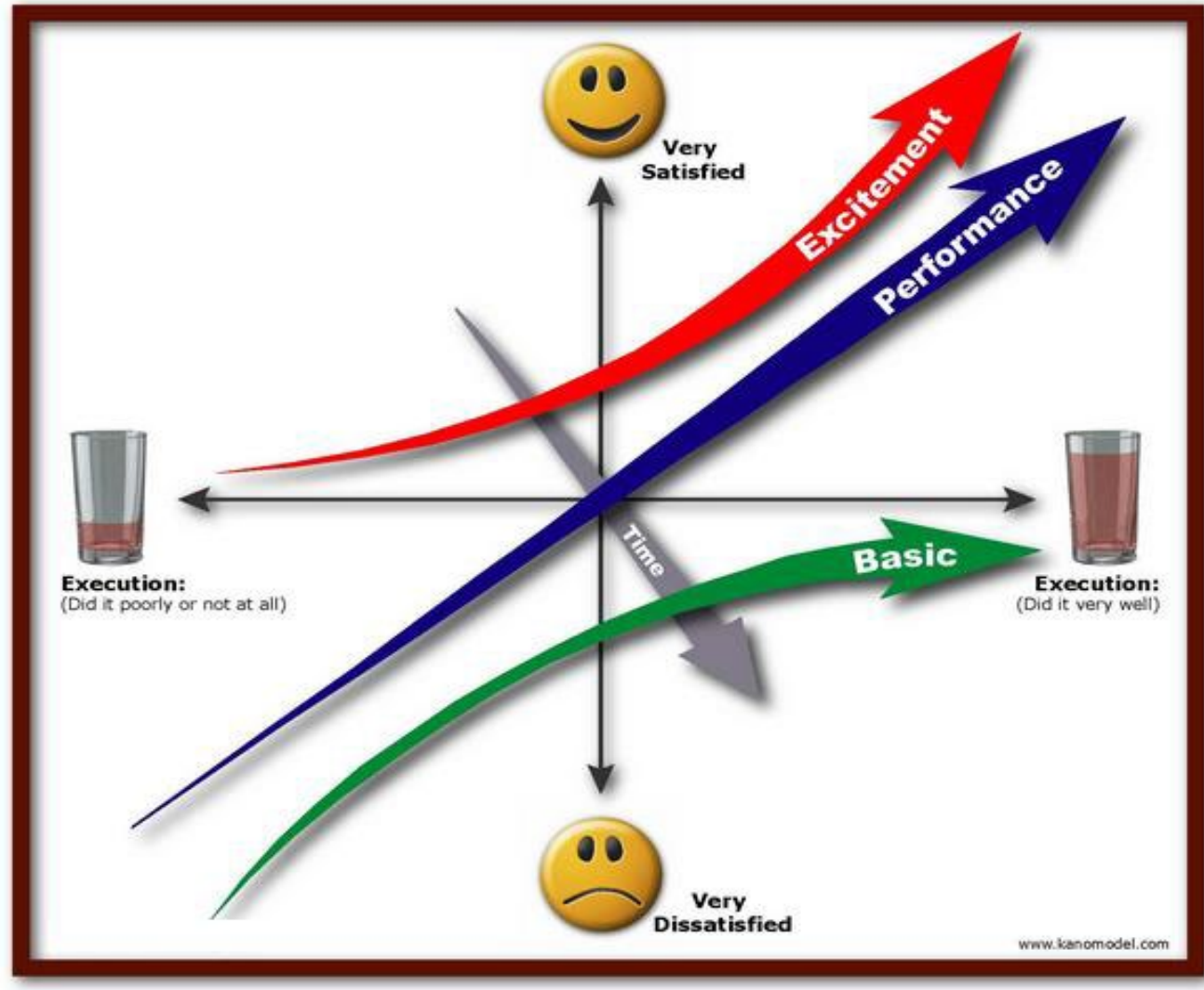
- Affinity diagram
- Kano analysis

Affinity Diagrams

- ❑ Associate similar features into groups
- ❑ We use it to consolidate similar features (perhaps from different customers) into a smaller number of common generalised features
- ❑ This provides clarity of the key areas and features needed to appeal to as many customers as possible
- ❑ These can be placed on a Kano diagram for example



The Kano Model



Developed in the 1980s by Professor Noriaki **Kano**, which classifies customer preferences into three main categories:

- 1) Basic (Must Haves)
- 2) Performance (Performers)
- 3) Excitement (Delighters)

The Kano model is used to differentiate between significant and distinguishing attributes related to the concepts of customer quality

The Kano Model

Critical To Quality (CTQ)*:

Helps us understand and **prioritise customers requirements**

Lets us differentiate between:

- What is absolutely necessary to the customer (what they **need**)
- What they would like to have but which is not essential (what they **want**)
- What they don't expect but which will make them absolute fanatics for your product or service and your company (what **delights/excites** them)

The Kano model is not a mathematically derived precision tool – it is a positional way of understanding and prioritising customer requirements

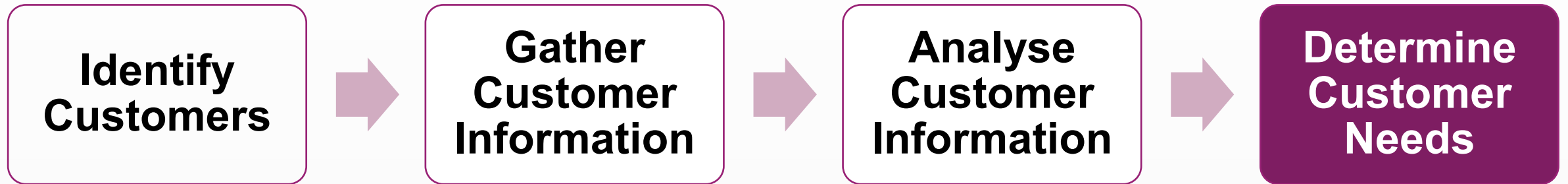
**Critical To Quality (CTQ) = Critical To Satisfaction (CTS)*

Kano – Feature set

From the Customer's point of view – every service (or product) contains features from the following categories:

Feature	Customer...	What it is
Basic Unspoken	Needs it	The essential feature set ('must have'). If a product or service lacks a basic feature the customer simply will not consider it, no matter how attractive it is otherwise.
Expected Spoken	Wants it	What the customer would expect from this type of product ('should have')
Exciting Unspoken	Delighted by it	Unexpected but desirable features not normally expected ('could have')
Dissuader Unspoken	Rejects it	Features which will actively dissuade our customer from considering our product

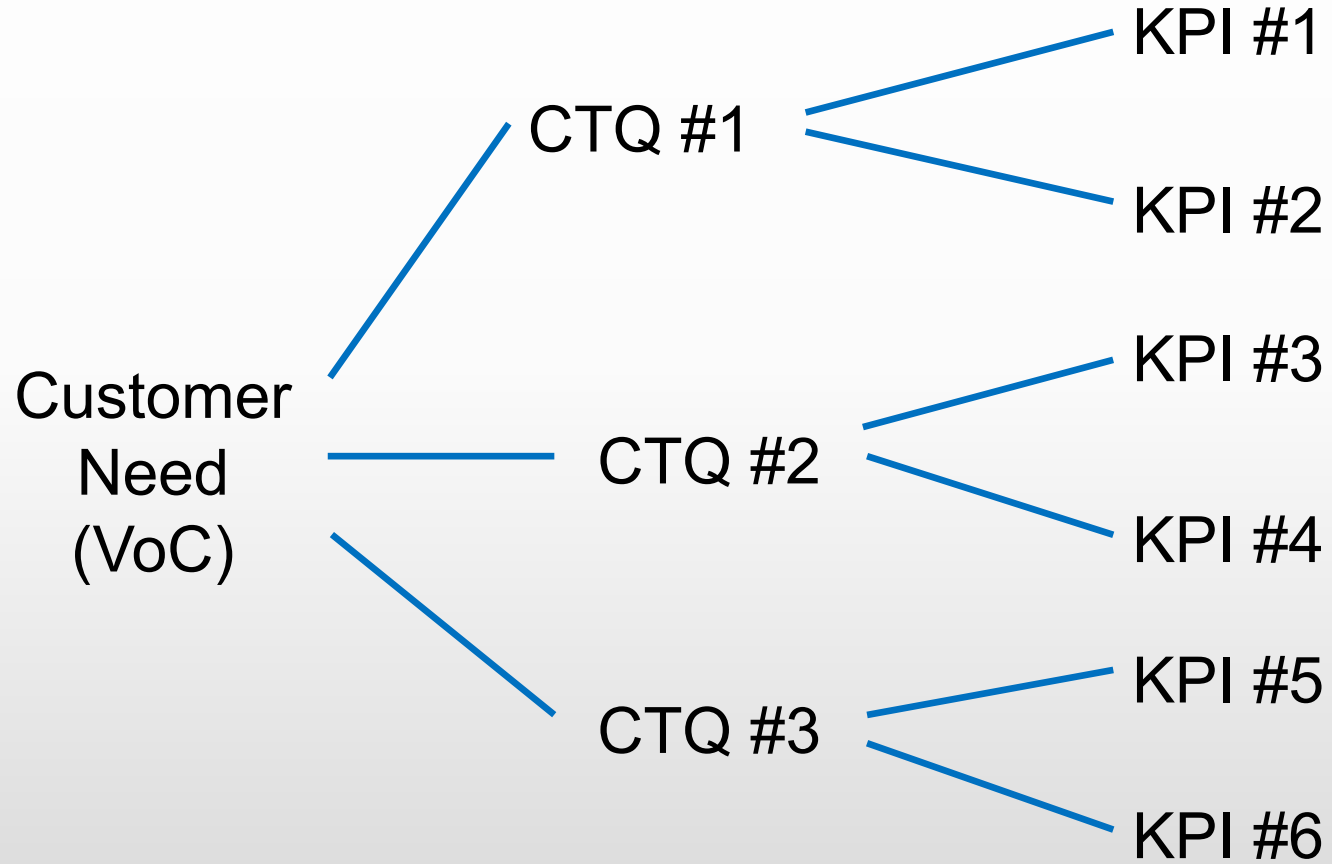
VoC Step 4: Determine customer needs



Objectives:

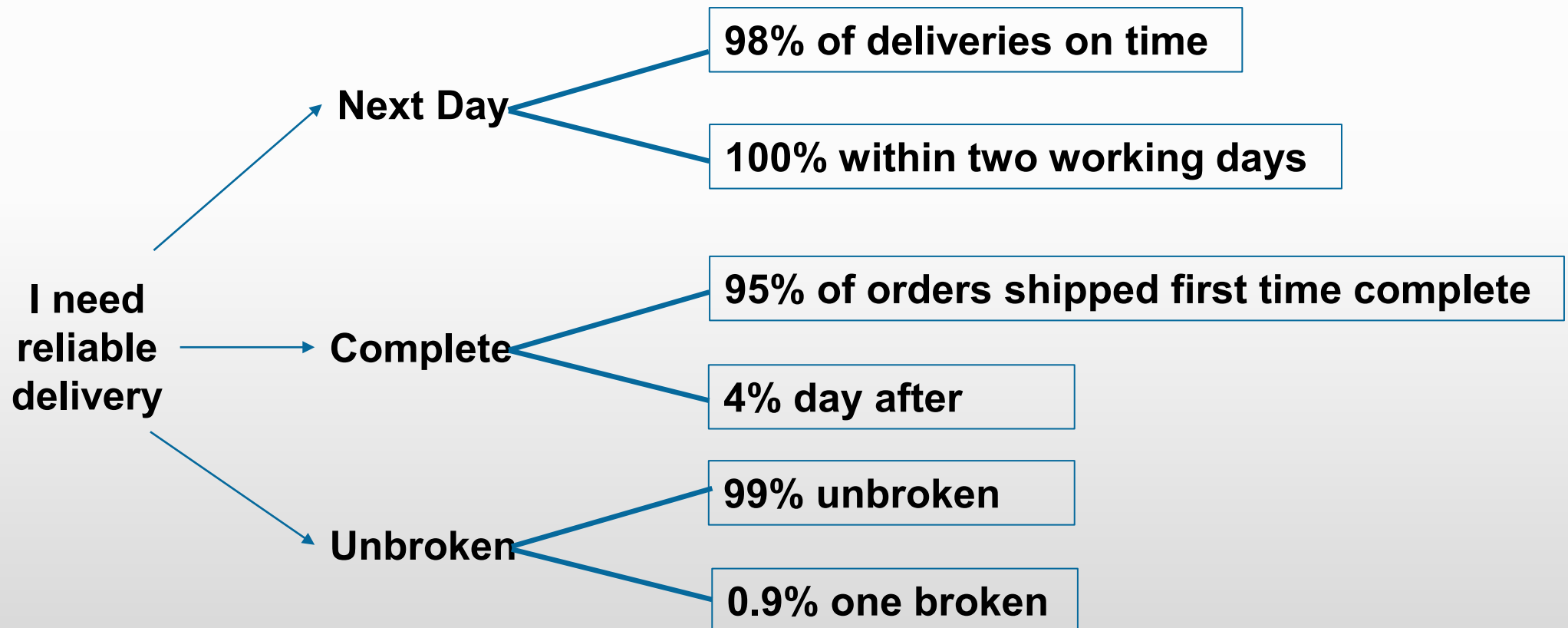
- Translate the customer language and identify the ***Critical to Quality*** requirements (CTQs)

Critical to Quality Trees



CTQ Trees: Identify KPIs

Once the CTQs have been identified, the team needs to define what level of service is acceptable to the customer (the KPIs):



What is a Critical To Quality (CTQ)?



It is important to the customer's buying decision

- The customer cares about it
- It is part of the customer's value equation

Specifies requirement – “must-have” or “must be” attributes

- Ultimately satisfy
- Potentially delight

Can be measured and related directly to the output of the business process

Establishes a target

- Customer specifications
- Acceptable range of performance

**Critical To Quality (CTQ) certifies useability, features, desired pricing and availability*

Critical to Quality (CTQ) Trees

A Critical to Quality (CTQ) Tree, is a diagrammatic tool that can be used as an aid to develop and deliver a product or service that will meet the requirements of your customers

A broad set of customer needs are translated into specific, actionable and measurable performance requirements

CTQ Trees help you understand what customers want from a process in a measurable way and identify areas of potential conflict to balance out

There are three steps to creating a CTQ Tree:

- Identify critical customer needs (VoC)
- Identify the CTQs which defines a need
- Identify the KPIs which supports a CTQ

You can then identify the statistics to collect (as part of your data collection plan)

Identifying the Requirement

VoC is the starting point but we need measurable targets to satisfy VoC/VoB

Critical To Quality requirements translate the aspirational VoC into something that is measurable (quantifiable) and that can be used as a yardstick

- In turn CTQs can be used to define Key Performance Indicators – for measurability

Improvement projects should be aimed at achieving KPIs

KPIs help identify the data we need to collect

Typically Define

VoC
“I need reliable delivery”

CTQ
“Reports delivered next day”

Typically Measure

KPI
“98% of deliveries occur by next working day”

Statistics to collect
“% of deliveries within time limit”

Yellow Belt Agenda

Introduction to Lean Six Sigma



Some Problem Solving Methodologies



Customers and Value



Project Charter

- Project Improvement Team
- Problem Statement
- Business Opportunity Statement
- Goal Statement

Some Lean Six Sigma Tools and Techniques

Project Charter

A Project Charter is a living document that outlines the issues, targets and framework for working on a process improvement



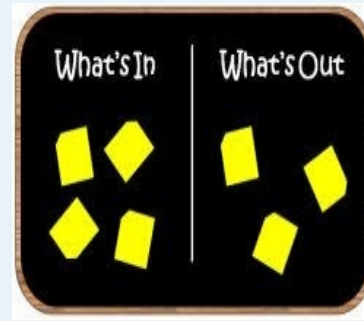
**Team
Development**

Those who will participate on the project



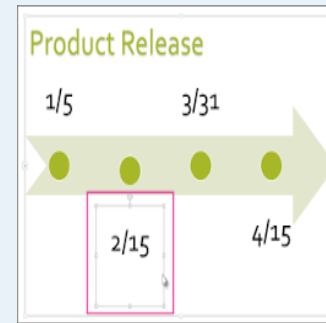
**Problem
Statement**

The problem captured - make it measurable



Scope

What areas the project will cover and what is excluded



**Business
Opportunity**

State the business reasons for fixing the issue



**Goal
Statement**

The SMART target to achieve the improvement



Timeline

When varied deliverables will be attained

Project Charter – Focus and Direction for a Team

Aids in communicating the purpose of the team
(why are we doing this?)


Clearly communicates the scope
(what is in / what is out)

Aids in team design and selecting participants
(do we need specialists?)

Helps to clarify roles and responsibilities

Clearly defines expected accomplishments
(benefits)

Outline approach the team will use
(get validated by a champion or BB)



The project charter is a team's blueprint for success

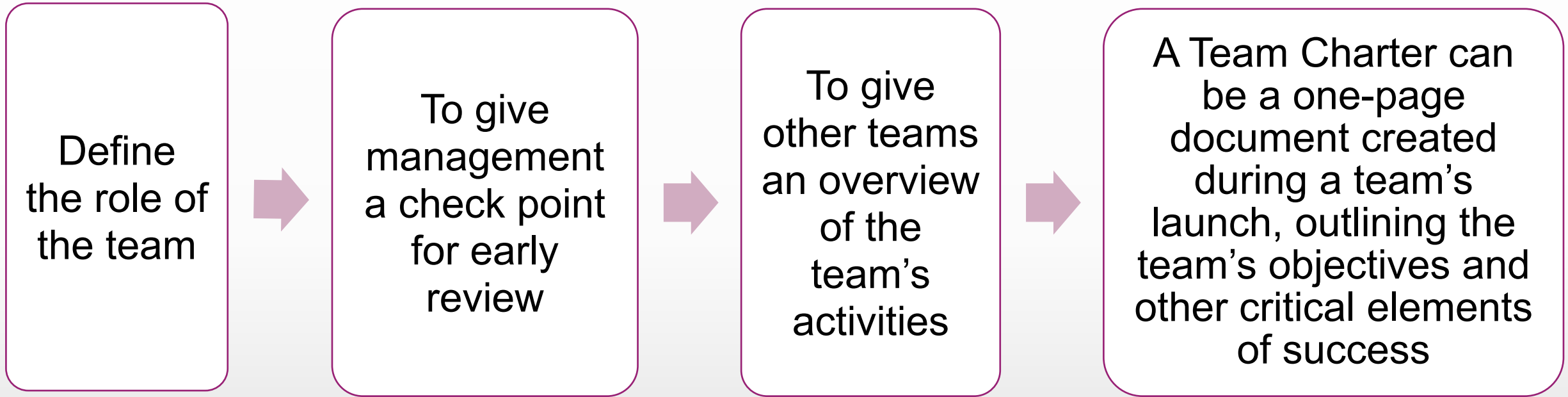
Lists specific deliverables

- Review charter regularly at weekly progress meetings
- Start reviewing plans

Typical Team Roles

Team Role	Attributes
Sponsor	<ul style="list-style-type: none">• Defines the scope and goals of the project• Makes available the essential resources required by the team to work effectively• Monitors and controls the progress of the team
Team Leader/ Facilitator/ Coordinator	<ul style="list-style-type: none">• Motivates, guides and helps the team to stay focused• Supervises team performance• Responsible for carrying out productive team meetings• Ensures the administration and documentation of the team's activities team• Ensures responsibility for specific tasks are adequately allocated among team members• Assists in avoiding and resolving conflicts
Coach	<ul style="list-style-type: none">• Coordinates with the team leader and facilitator to help the team function adequately• Assists team members in fulfilling their obligations by deploying relevant skills
Team Member	<ul style="list-style-type: none">• Participates in team meetings and shares their own views• Use own expertise to accomplish assigned tasks

Team Charter



Keep it Lean
Keep it light!

A Simple Team Charter Format

What is it that the team is trying to address?

e.g. The delivery of accurate reports, with data from various sources

Clearly defines what the team is to do (and NOT to do!)

e.g: The team will ensure that reporting database is available to respective project managers who are trained to input the data, but it will not verify the data sources

The aims of the team

e.g. to deliver respective accurate project reports within three months of year end

Identifies the key people who need to be involved and allocating defined roles, as appropriate

e.g: Leader, Facilitator etc

Issues	Scope
Objectives	Deliverables
The Team	

What will be the output/outcome of the team's work?

E.g. Established reporting database
Redesigned process
OTGIs + training

- **Single piece of paper (can be large)**
 - **Keep it up to date**
- **Can add other sections if you wish**

Managing Progress and Demonstrating Control

Why?

- ❑ Teams are self-directed and autonomous
 - However, control and direction are still necessary
- ❑ It is the responsibility of the Team Sponsor to satisfy themselves that the team is in control

How?

- Use of Team / Kanban Board
- Daily stand-up
- MoSCoW prioritisation

Team Boards

Contain relevant information to allow the team to understand and perform their work

Allow them to track trends

Pick up on waste

Simple graphical information

- ❑ The Board belongs to the team
- ❑ Makes a topic of conversation – it is not decorative wallpaper!
 - ❑ Boards need to be accessible and close to the workplace
 - ❑ Visual management boards do not have to look beautiful

Team/Kanban Board

Visually illustrates the progression of tasks

Simplest version shown, however you may want to add extra columns depending on your business environment	Signed off Passed User Acceptance Testing Shipped Etc
--	--

Tasks can be prioritised perhaps using MoSCoW

Can be part of the Team Board

Kanban board



Daily Stand-ups

Ideally scheduled first thing daily

- **All** Team Members attend
- Wider stakeholders (including Leaders) can attend as non-participating observers

Each team member has *2 minutes* to report to the group:

1. Work and activities performed since last meeting
 2. Work and activities planned for the next period
 3. Any potential barriers to individual or team progress
- Additionally – group leader sums up

Short and focused

- No discussions (these can happen *after* the stand-up ends)

Stand-ups maintain progress, demonstrate control and improve team integration and morale

Problem Statement

Focus

- ❑ Formulating a problem is a teamwork exercise. Some basic questions to ask, include:
 - What is the problem?
 - Why is this a problem?
 - Where does this occur?
 - How often, how bad, how expensive?
 - What is the implication if we do not solve it?

Key Points:

- ❖ Describe briefly and avoid technical jargon – focus on the symptoms (who feels the pain, and where is it felt)
- ❖ Do not propose or imply a solution
- ❖ Do not delve into root causes of the problem here
- ❖ Define the scope and identify key stakeholders
- ❖ Included in Project Charter

What does a Good Problem Statement look like?

A good *Problem Statement* should signify:
When / What / Magnitude / Impact or Consequence

Example of a Poor Problem Statement

Our employees are upset and disillusioned with the time it takes to claim their repayment following a mission trip

Example of a Good Problem Statement

In the last 12 months (**when**), staff have received a repayment for mission trip claims in an average of 30 days from the date of the submission (**what**), whereas they need to repay their credit card bills in no more than 14 days after the initial spending days (**magnitude**). This results in employee dissatisfaction and loss of productivity for time spent chasing their repayment (**impact/consequence**)

Cost of Poor Quality

What is CoPQ?

- Simply, just what it is referred to. Cost of Poor Quality is how much money a non-conforming deliverable costs your organisation... The “**How Much Does it Hurt**” metric.
- And quite a valuable metric it is! As the first key measurable in any Six Sigma project, it shows you, your team, and management the pain caused by the non-conforming condition or defect. Importantly, it shows how much pain.
- CoPQ is measured to obtain a baseline measure of where you are today in terms of costs. However, you can also use this measurement to **sell** improvement projects to management.
- CoPQ shows your management why it is critical that you begin your project now.



Cost of Poor Quality Categories



Cost of Poor Quality Categories

Prevention

- Error Proofing Devices
- Supplier Certification
- Design for Six Sigma
- Etc...

Appraisal (Detection)

- Supplier Audits
- Sorting Incoming Parts
- Repaired Material
- Etc...

Internal CoPQ

- Quality Control Department
- Inspection
- Quarantined Inventory
- Etc...

External CoPQ

- Warranty
- Customer Complaint Related Travel
- Customer Charge Back Costs
- Etc...

Business Opportunity

Focus

- ❑ L6S is different from *project management* in that at the *Define* phase, the solution is rarely known or if the process can be improved
 - So, a formal *cost-benefit* analysis is often impossible
- ❑ The simple *Business Opportunity* is that the owner of the process has an issue which they believe requires attention
- ❑ At *Define*, if the solution is known, then just implement it (L6S DMAIC is n/a)

Key questions to consider:

- ❖ Why is the project worth doing?
- ❖ Why is it important to do it now?
- ❖ What are the consequences of not doing it?
- ❖ What is the cost of dealing with the process failure?
- ❖ What activities have equal or higher priority?
- ❖ How does it align with current business strategy?

Sample Business Opportunity Statement

A good *Business Opportunity Statement* should capture:

- Why it is important to do this now
(from the Champion's point of view)
- Some form of financial justification (or reference to CoPQ), where possible

Example of a Business Opportunity Statement (1)

Streamlining an organisation's processes is always a good thing. So, centralising the tasks that are not country-management focussed will make the process better.

Example of a Business Opportunity Statement (2)

In support of the organisation's strategy to become efficient with its processes – eliminating unnecessary hard copy reports, centralising certain functions and placing other reports online – it is expected that we can reduce the time spent on non-value tasks within the country-management processes.

Which of these is a good Business Opportunity statement?

Goal Statement

Make it SMART

- S**pecific – An observable action, behaviour or achievement linked to a rate, number, percentage or frequency. {*Answer the phone*}
- M**easurable – A system, method or procedure exists to allow the tracking and recording of the behaviour {*Within 3 seconds*}
- A**greed – Objectives aligned to business strategy and agreeable to relevant stakeholders
- R**ealistic – Objectives can be attained (not necessarily easy or simple though)
- T**ime-bound – When the objective can be met

GOAL: In line with meeting customer expectations, customer services will be able to answer the phone within 3 seconds from 1 March 2020

SIPOC

A first cut, **High level** view of the area to be improved

Identifies: Suppliers, Inputs, the Process, Outputs and Customers

Identifies the scope of the improvement project

- Shows us the task

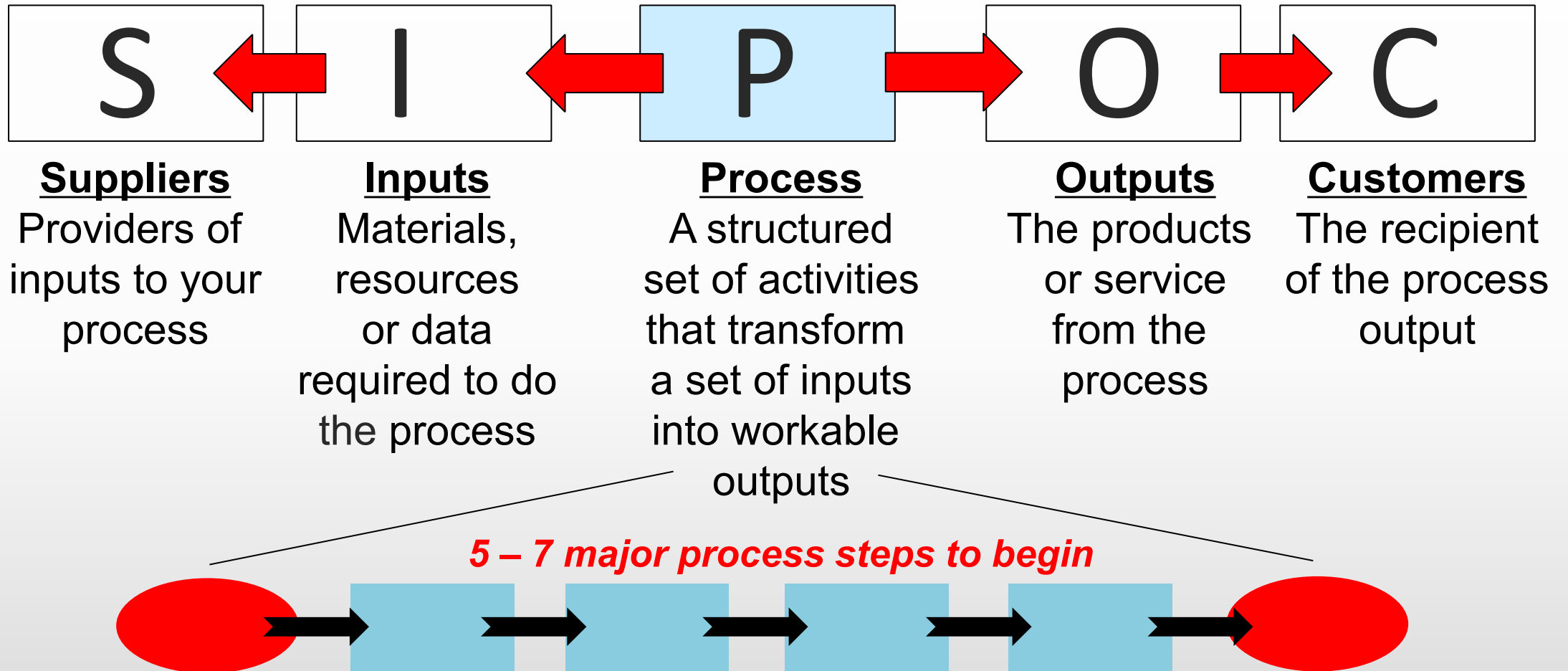
Scoping an improvement project is **critical** to achieving success

- Don't take on too much!
- A SIPOC will allow you to gauge this and help narrow the focus

SIPOCs provide the following benefits:





- Enables the entire team to have a focus for the workflow to be improved
- Ensures that the key players are identified
- Clarifies an understanding of the scope of the work between management and the team
- May identify 'quick wins' that can provide an early improvement

Example SIPOC



S.I.P.O.C is used to identify high level AS-IS processes – an effective communication tool

SIPOC Example – Proposal Submission

Supplier	Input	Process	Output	Customer
Who provides the input?	List input to activity	Name of activity	List output of activity	Who receives the output?
<ul style="list-style-type: none"> Client Proposal team Project Managers 	<ul style="list-style-type: none"> Client information Project information RFP documents Previous experience 	<div style="border: 1px solid black; padding: 5px; text-align: center;">Qualify Opportunity</div> 	<ul style="list-style-type: none"> Bid/No-Bid decision Internal memo 	<ul style="list-style-type: none"> Consultancy teams Sales & marketing
<ul style="list-style-type: none"> Sales & Marketing Consultancy teams 	<ul style="list-style-type: none"> Project information Client information RFP documents Market studies 	<div style="border: 1px solid black; padding: 5px; text-align: center;">Define requirements</div> 	<ul style="list-style-type: none"> Client requirements documents Benchmarks 	<ul style="list-style-type: none"> Consultancy teams Operations Director PM's
<ul style="list-style-type: none"> PM's Operations Director Consultancy teams 	<ul style="list-style-type: none"> Resources skills Plans (availability) Client requirements RFP documents 	<div style="border: 1px solid black; padding: 5px; text-align: center;">Identify resources</div> 	<ul style="list-style-type: none"> Initial Project Team composition Project Team costs 	<ul style="list-style-type: none"> PM's Sales & Marketing
<ul style="list-style-type: none"> PM's Client Sales and Marketing 	<ul style="list-style-type: none"> Resources /team Client requirements RFP documents Plans and assessments 	<div style="border: 1px solid black; padding: 5px; text-align: center;">Create technical & commercial proposal</div> 	<ul style="list-style-type: none"> Final Proposal Document (technical + commercial) Budgets and Plans 	<ul style="list-style-type: none"> Proposal Team Clients PM's
<ul style="list-style-type: none"> Proposal team 	<ul style="list-style-type: none"> Proposal document 	<div style="border: 1px solid black; padding: 5px; text-align: center;">Submit bid</div>	<ul style="list-style-type: none"> Proposal submitted 	<ul style="list-style-type: none"> Client

Review Questions

- In what document can you state why your project is important and what the problem and goals are?
- What is the VoC? What method(s) can you use to ascertain VoC?
- What are the four steps of the VoC methodology?
- What are the 5 steps of the DMAIC methodology and what do they represent?
- What techniques can be used to identify customer requirements and link them to metrics?
- What is the VoP?
- What is CoPQ?

Yellow Belt Agenda

Introduction to Lean Six Sigma



Some Problem Solving Methodologies



Customers and Value



Project Charter



Some Lean Six Sigma Tools and Techniques

- Introduction to Processes
- Measurement and Analytical Tools and Techniques
- Solution Tools and Techniques

Introduction to Processes

- ***What is a Process***
- Types of Measure
- Gemba Management
- Process Stapling

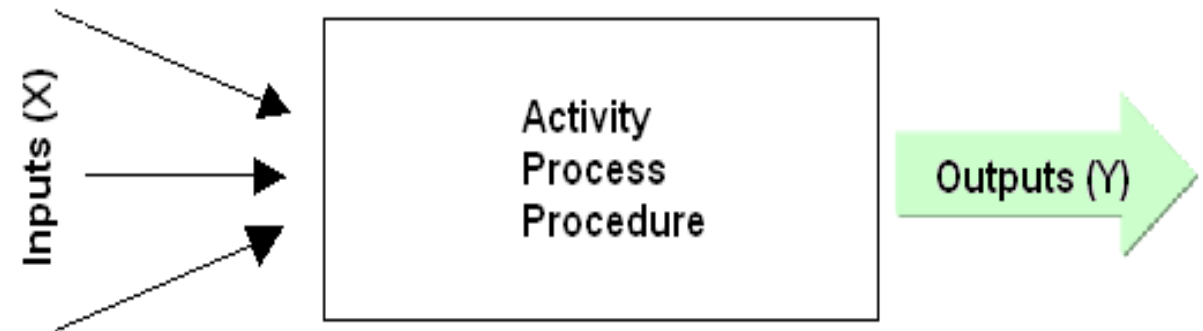
What is a Process?

Everything!

- *Any activity, process or procedure that transforms one or more inputs into one or more outputs*

Examples:

- Processing an order
- Filling in a purchase requisition
- Making a car door handle
- Brushing your teeth
- Painting a room



Anatomy of a process

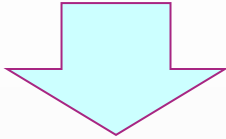
$$Y = f(X)$$

Question:

Which parts of the process have we historically focused on?

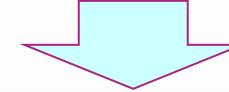
Types of Processes

Making things



Manufacturing

Providing a service



Service

Transactional

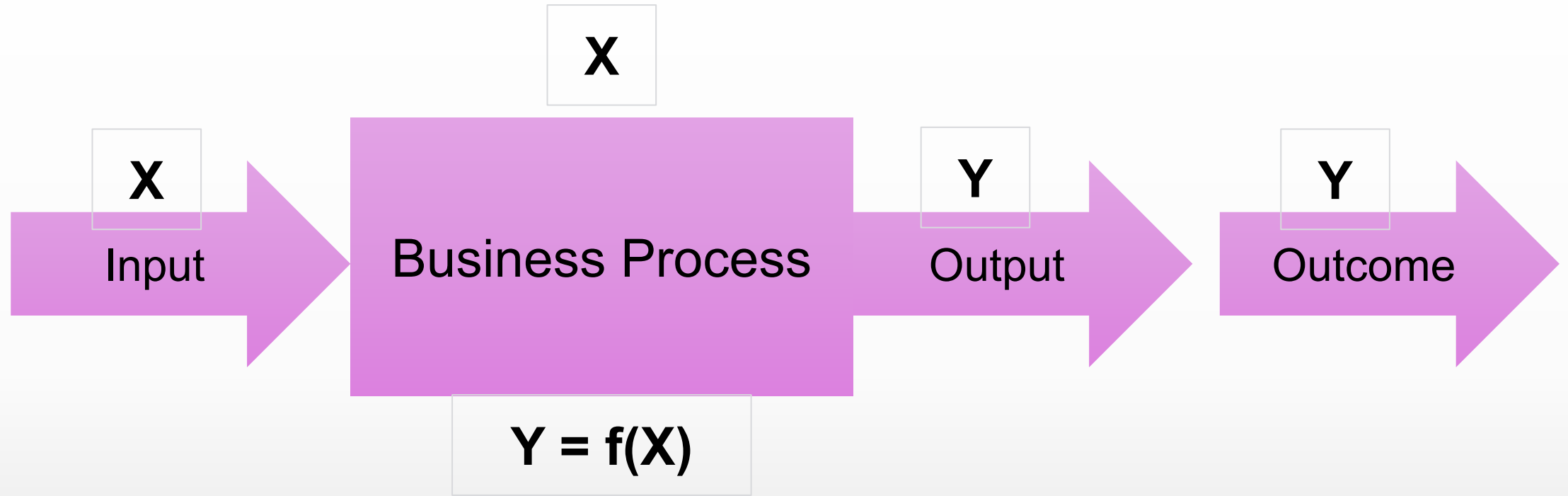
Interactive

Manufacturing	The path a product takes from its creation to delivery to a customer
Service	<p>The customer's journey</p> <p>How a service provides a solution to a customer</p> <p>Service processes can be split depending on the amount of <i>End Customer</i> interaction there is</p>

Introduction to Processes

- What is a Process
- ***Types of Measure***
- Gemba Management
- Process Stapling

Types of Measure



Input:	Resources including cost and workforce
Process:	Activities, efforts, workflow
Output:	Product or service delivered
Outcome:	Results, accomplishments, impacts from output

Types of Measure – Input

What do we need for our work?

The '4 M' rule

M A T E R I A L S

M A N P O W E R

M A C H I N E S

M E T H O D



Introduction to Processes

- What is a Process
- Types of measure
- ***Gemba Management***
- Process Stapling

Gemba (The Real Place)

Gemba can be translated as:

- The real place
- The place where work gets done
- The shop floor

As a philosophy, Gemba is a reminder to managers of all levels that sitting in an office isolates them from 'real' processes and work. In Gemba, there is a drive for management and leaders to stay connected with the shop floor (the place where the real action occurs).

By practising the Gemba philosophy, management gains a deep and thorough understanding of real-world issues, by first-hand observation and by talking with plant floor employees



Some Gemba Management Tools

Gemba Walk

Management go to the workplace daily to observe and look for potential problems and wastes

Managing By Wandering Around (**MBWA**)

Management tries to stay and work in Gemba as much as possible

Genchi Genbutsu [Go Look See] (Boots On The Ground)

No business decisions are made without visiting the relevant part of the business – ideally, the decision is made by managers while standing on the shop floor

Introduction to Processes

- What is a Process
- Types of measure
- Gemba Management
- ***Process Stapling***

Process Stapling

Following a process through 'end-to-end'

Record everything that happens

- Even the unexpected and one-offs

Video is useful

Make sure this does not have a negative effect on the people in the process

- Make sure they know it is not about testing them
- Possible have staff do the recording

Some people prefer to work through a well known process backwards

Measurement & Analytical Tools and Techniques

- ***Process Maps: SIPOC / Swim Lane / Value Stream Maps***
- Spaghetti Diagram
- Basic Statistics: Data Types / Population & Sample / Measuring Data (Average & Variability Indicators)
- Statistical Process Control (SPC) & Graphical representations
- Process Efficiency
- 5 Why's
- Fishbone (Ishikawa) Diagram

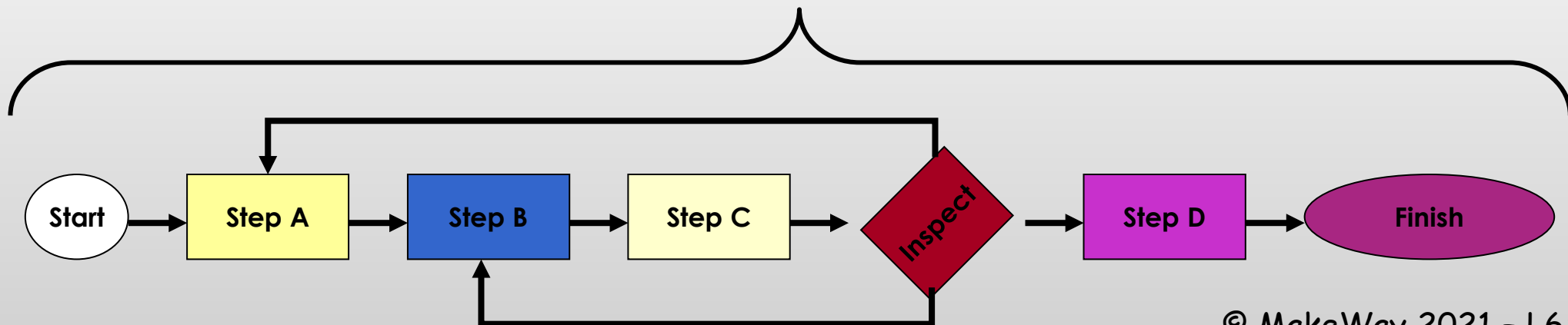
Process Maps

Types of Process Maps

- ❑ High level process map
- ❑ Detailed process map
- ❑ Swim Lane process map
- ❑ Value Stream Map

Key Points:

- ❖ A way of illustrating the flow of a process
- ❖ Describes how the flow works and identifies the complexities therein
- ❖ In L6S, the *Process Map* forms the basis of a Value Stream Map
- ❖ The *Process Map* communicates the focus of problem solving



Process Maps

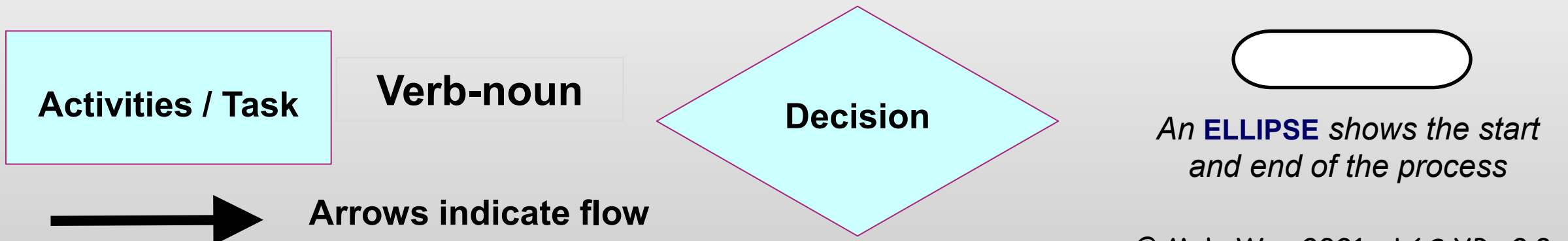
Process Maps are living documents and must be changed as the process is changed

→ They represent what is **currently** happening not what you **think** is happening

→ They should be created by the people who are closest to the process

Usually the 'flow' of the process is left to right although can be top to bottom

Each step is recorded as a symbol linked by arrows showing the flow



Advantages of Visual Mapping

Provides a
VISUAL
representation
of the process

Mapping out the
actual process
enables an
objective view
of reality

Identifies re-
work loops and
redundancies

Serves as a
training and
orientation tool

Identifies non-
value added
steps

Helps identify
where in the
process data can
be collected from

Identifies where
different work
teams use different
processes

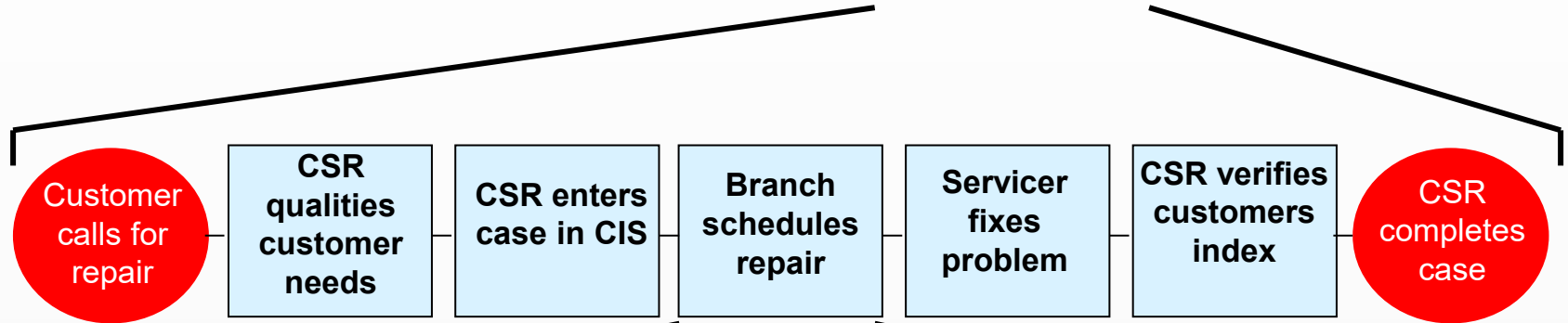
Process Maps form the basis of Value Stream Maps

Example Process Map

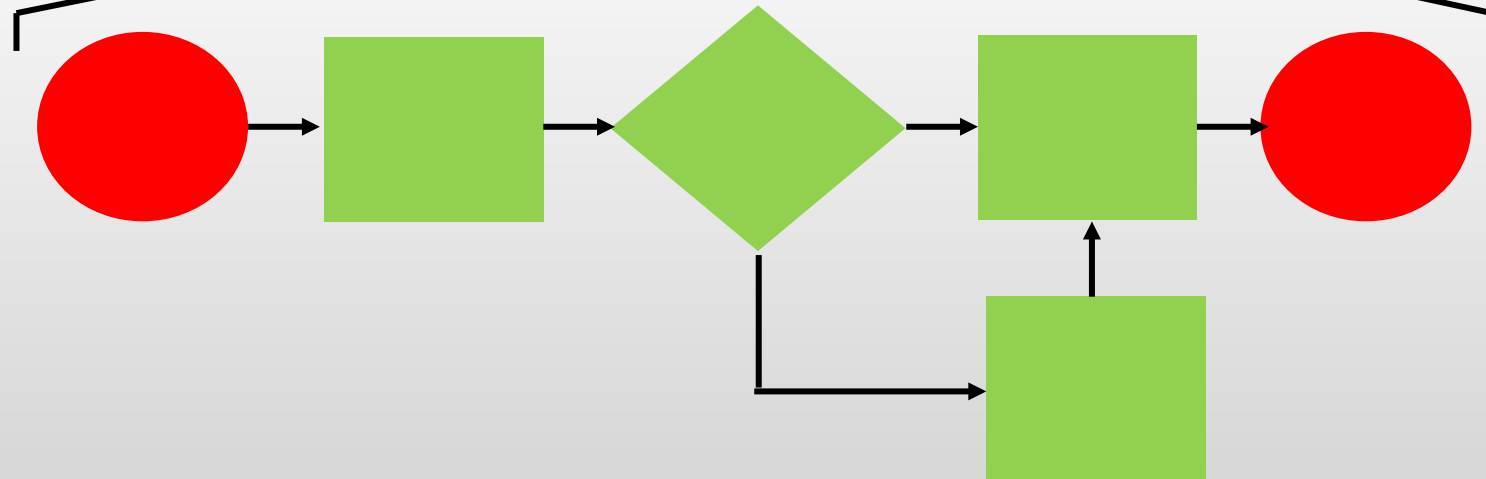
Core process
(level 1) SIPOC



Sub-processes
(level 2)



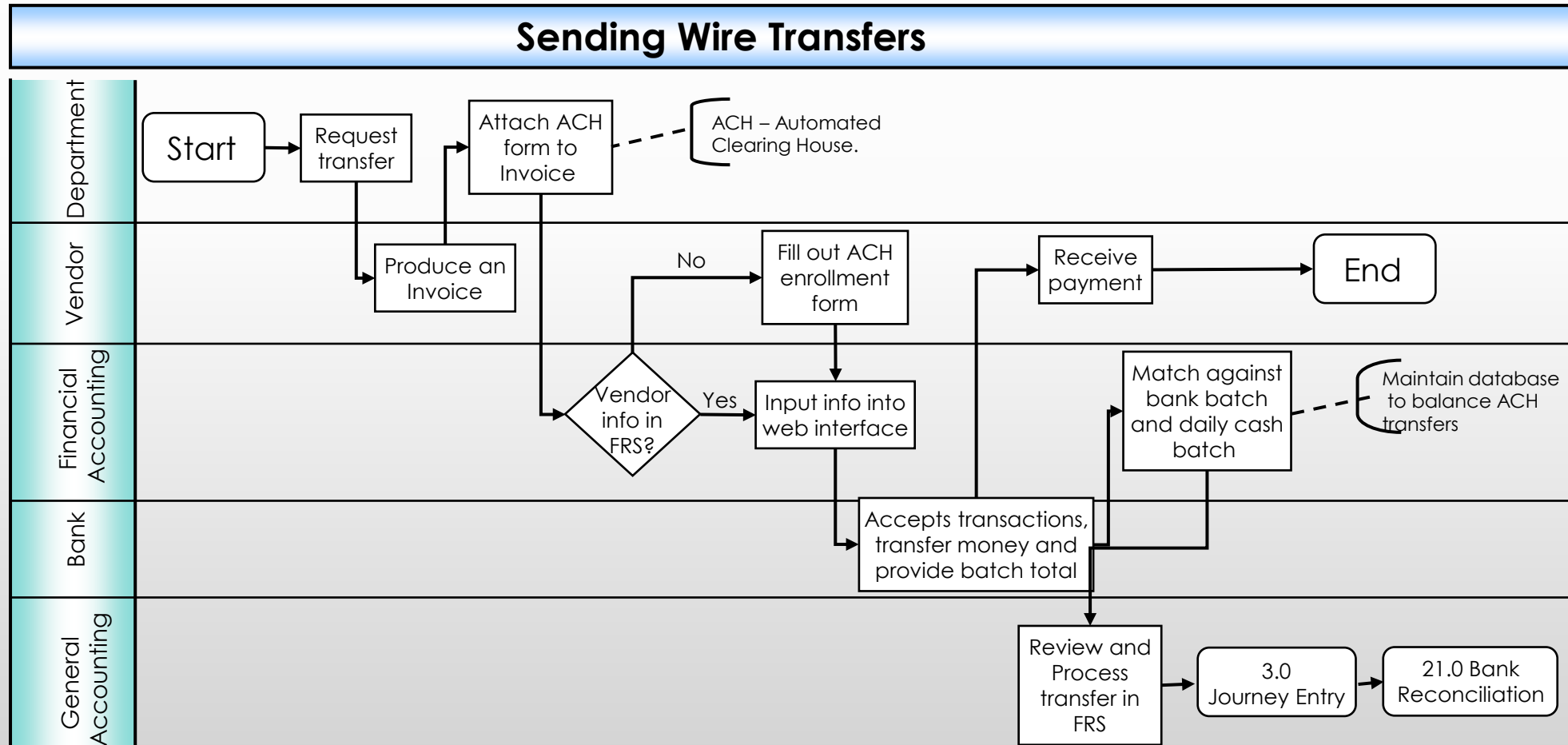
Sub-processes through
micro-processes
(level 3)



Swim Lane (or Cross-Functional) Chart

When multiple departments or functional groups are involved in a complex process it is often useful to use Cross Functional Process Maps.

- Draw in either vertical or horizontal Swim Lanes and label the functional groups then draw the Process Map



Value Stream Maps (VSMs)

A value stream map builds onto a process map by illustrating the flow of value through the process

This includes....

- People and other resources
- Value and Non-value added time
- Inventory
- External and internal movement
- Communications (verbal, electronic etc)

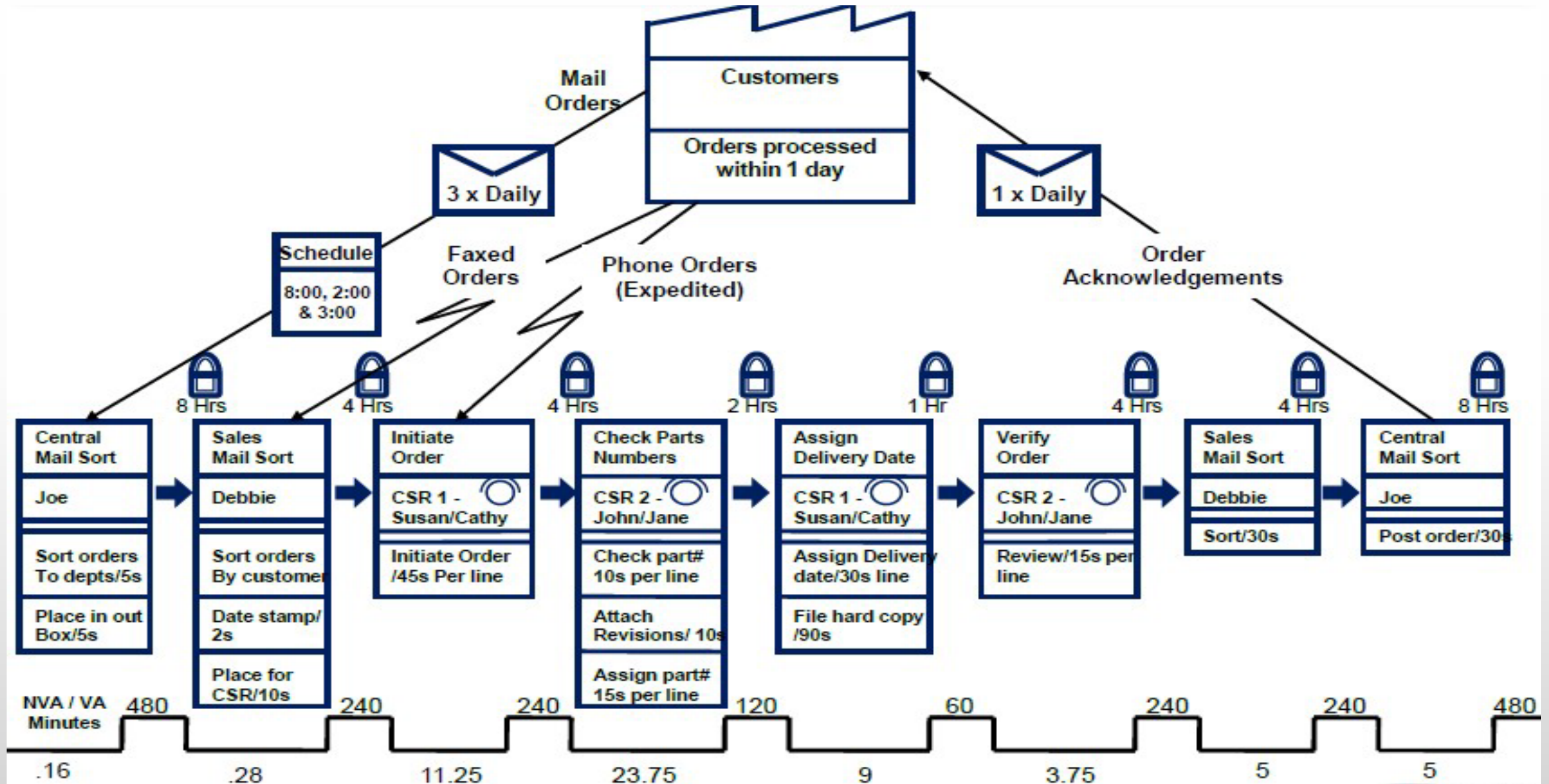
A VSM is useful for identifying bottlenecks and areas that could be improved

Creating a map on a large sheet of paper is still considered best as...

- It visually displays the end-to-end process
- It can be brought alive with photos and sample documentation
- It is an excellent engagement tool

A VSM is an excellent engagement tool that can also be brought alive with photos and sample documentation

Value Stream Mapping ('As Is')



Value Stream Mapping enables us to:

Show in simple graphical terms the entire operation – ***End to End***

Agree upon the ***AS IS*** state

Remove silos – make the value stream flow

Identify waste (including the source of waste) and Non-Value add activities, so that we can make improvements without adversely impacting the customer

Design the ***TO BE*** state and get validation

Understand and increase value added activity

Value Stream Analysis tools are about analysing the current state (AS IS) and designing and quantifying the future state operations (TO BE)

Creating the 'AS-IS' VSM

Go to the Gemba and examine the process

Identify the scope of the Value Stream Map

- A SIPOC might help here

Identify logical blocks/cells

- Flow chart or Swim Lane diagrams can be useful here

Gather data using a Data Collection Plan and appropriate forms

Create the Current State Value Stream Map, showing:

- Material Flow
- Information Flow

VA+BNVA/
NVA
classification

In step 5 you can use the six-step creation process described a little later in these notes

Investigating the Value Stream Map

1. Where do you see waste (**muda**) in this process and what types of waste do you see?
2. What counter-measures could be taken to reduce the most significant forms of waste?
 - a) Get management approval
 - b) Communicate to all areas before visit
 - c) Make introductions when you get there
 - d) Remember, the workers are the experts for their tasks!
 - e) Respect people's workspace
 - f) Explain your purpose

Creating an Improved Process

Examine the 'As Is' ('current state') process map and investigate the areas of potential waste

Perform a *Root Cause Analysis (RCA)* to identify the true cause(s) of the waste

Estimate how much the waste is costing

Consider if it is practical and feasible to remove or reduce the waste at this time

- Team skills/ complexity of the rectification
- Potential cost of action
- Company culture

Re-draft the VSM illustrating how the process would look with the selected wastes removed (the '**to be**' / '**desired**' or '**future state**')

Measurement & Analytical Tools and Techniques

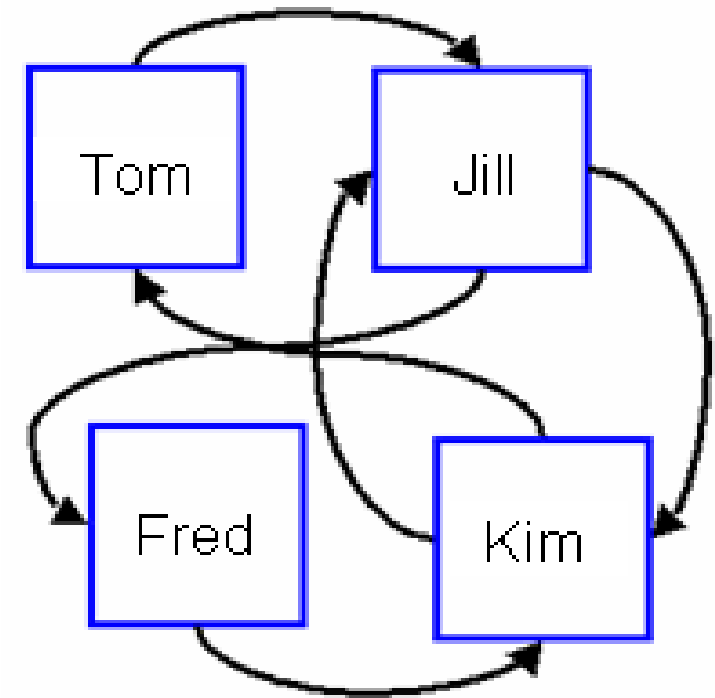
- Process Maps: SIPOC / Swim Lane / Value Stream Maps
- ***Spaghetti Diagram***
- Basic Statistics: Data Types / Population & Sample / Measuring Data (Average & Variability Indicators)
- Statistical Process Control & Graphical representations
- Process Efficiency
- 5 Why's
- Fishbone (Ishikawa) Diagram

Spaghetti (Movement/Transportation) Diagrams

Tracks how a piece of work physically moves during production

This could be:

- An electronic document passing between staff (illustrated)
- A mechanical part being assembled
- A car tyre being fitted
- A sales person handling a shoe request



Example Impact of Shared Equipment

Distance travelled to e.g. printer Dept A = 92 ft. per trip

Dept B = 696 ft. per trip

120 occurrences per day = 4656 miles/year

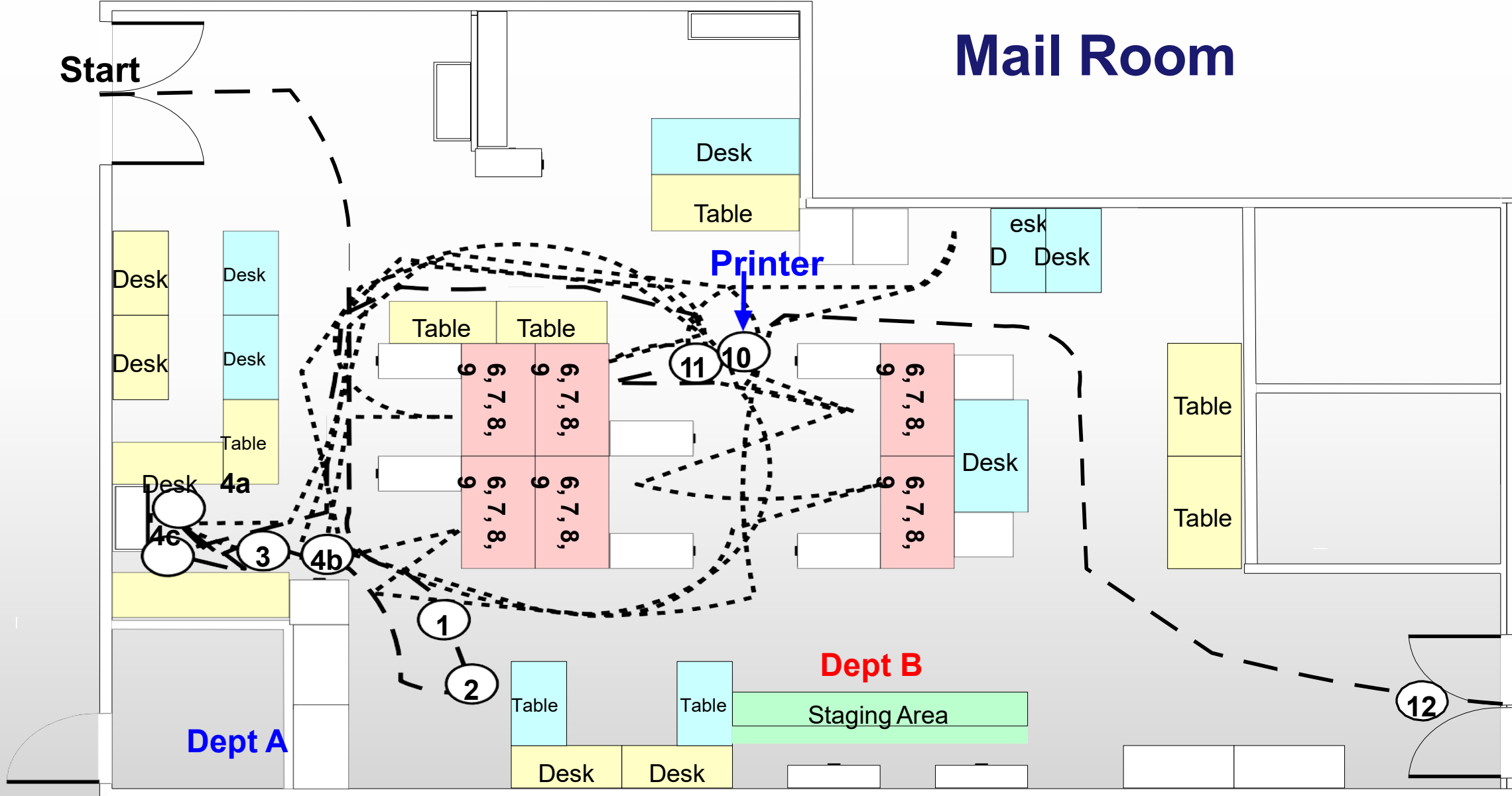
Walk pace = **582 days/year** of unproductive, non-value-adding time

= 1 mile per hour = **4,656 hours**

= **2.4 FTEs**

Spaghetti (shows people and deliverable travel) Diagrams

Mail Room



Measurement & Analytical Tools and Techniques

- Process Maps: SIPOC / Swim Lane / Value Stream Maps
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- ***Basic Statistics: Data Types / Population & Sample / Measuring Data (Average & Variability Indicators)***
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Measurement System Analysis (MSA)

The tools that you use to measure your data and the way that you use them, will add distortion to your data

- **Bias** – data is shifted up or down from its real values
- **Precision** – additional variation is added to the data

If there is too much distortion in your measurement system then your findings could lead you to seriously wrong conclusions

Make sure your measurement tools (gauges) are able to measure to the correct resolution needed and that people using them produce the same results

Data Types

Variables are things that we measure, control or manipulate in research



But we measure different types of things:

- 1) Number of employees in a department (1,2,3...)
- 2) Overtime hours worked by each employee
- 3) Whether anyone has been trained (Yes/No)



The type of data and the way we measure our data (the “*type*”) will determine the statistical models that we can use

When choosing variables think about the degree of detail required as well as the team’s ability to collect the data

Basically we measure two types of data...

Data type	What it is	Example ...
Numeric data	The value that we measure has a numeric meaning	Temperature in a room (Continuous) People in a room (Discrete)
Attribute data	The data identifies plots by the presence of an attribute or feature	Gender An item is acceptable or not Number of faults in a batch

Numeric data consists of two types:

- **Continuous Data** – the value can take any number between identified limits (in the table above, the first example – ‘Temperature in a room’ is continuous)
- **Discrete Data** – the value can only take specific numbers between identified limits (in the table above, the second example ‘People in a room’ is Discrete)

You need ‘tool’
to Measure

What you
can count

Frequency and Sample Size

Frequency

Look for blocks and boundaries that might illuminate the problems you are investigating. For example, could work shifts or the day of the week be significant?

Can you identify any cycles in the process (ask the people in the process or investigate what customers think)

Attempt to sample at least 4 times within the shortest cycle or block and measure over 4 cycles if possible

Sample Size

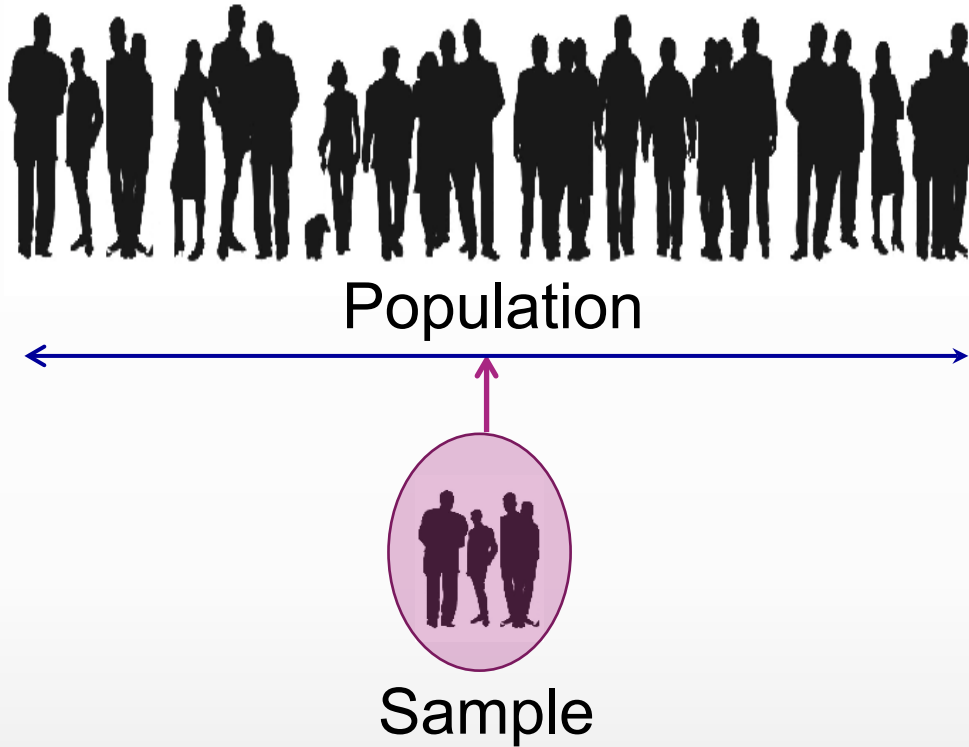
You need a big enough sample to model the system and answer your research questions

The type of data collected influences the sample size

Big one-off units are best measured individually

For small parts, measure a group and aggregate

Population and Sample



How representative is the sample of the full population?

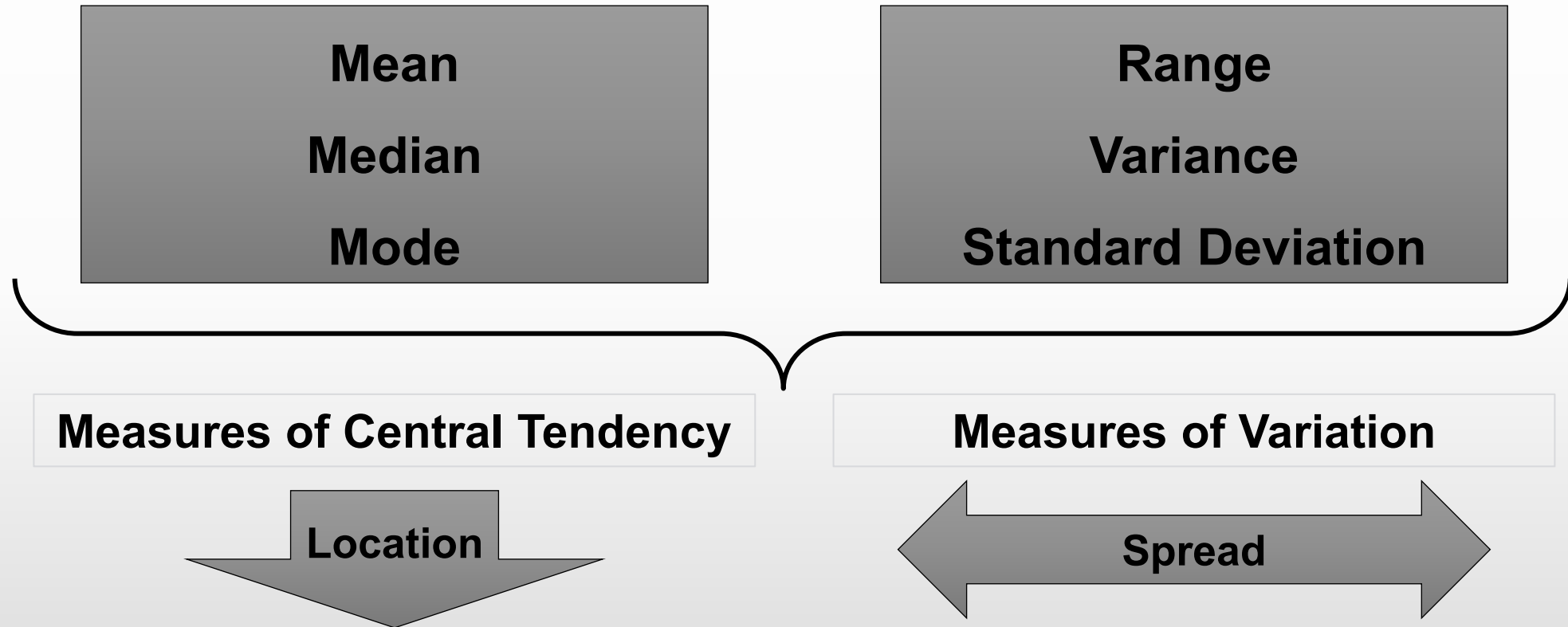
How much confidence would you have in forecasting from the sample to the population?

Population Size	Suggested Minimum
2 – 8	2
9 – 15	3
16 – 25	5
26 – 50	8
51 – 90	13
91 - 150	20
151 – 280	32
281 – 500	50
501 – 1200	80
1201 – 3200	125
3201 – 10000	200
10001 – 35000	315
35001 – 150000	500
150001 - 500000	800
> 500000	1250

Adapted from MIL Master Table for Normal Inspection (Guide to Quality Control; K Ishikawa)

Basic Statistics – Numeric Representation

Sample data can be summarised in two forms:



Central Tendency + Measures of Variation provides a summary of the data set

Centre of Data: Averages

Mean

- The sum of values divided by the number of values
- Most useful average in statistics
- Normal distribution peaks around the mean

2,2,5,6,7
Mean = 4.4

Median

- The mid-point value amongst all our values
- We have to use this if the data is skewed (ie with Poisson)
- Will give less accurate forecasts than using the mean

2,2,5,6,7
Median = 5

Modal

- Most frequently occurring event
- Useful when we categorise items than cannot be ordered (e.g. eye colour)

2,2,5,6,7
Modal = 2

Measures of Spread in Data: Variability Indicators

Range

- Subtract the smallest observation (minimum) from the largest observation (maximum)

Standard Deviation

- It is a measure of dispersion or spread
- It is always greater than or equal to 0 (zero)
- Obtained by taking the square root of the *Variance* and measures the spread around the *Mean*.

Variance

- Obtained by averaging the squared deviations of observations around the *Mean*. Because its units are the square of the variable Y , it is a measure that is not used directly, but to calculate *Standard Deviation*.

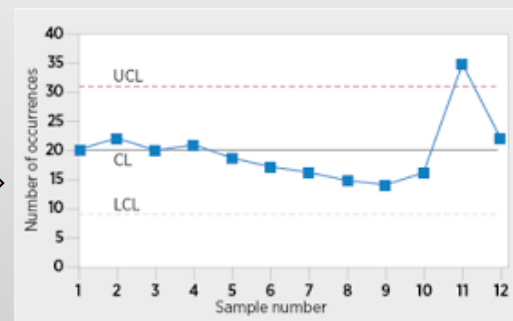
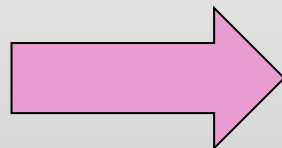
Measurement & Analytical Tools and Techniques

- Process Maps: SIPOC / Swim Lane / Value Stream Maps
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Statistical Process Control (SPC)

- SPC is a group of tools which model a system using some form of statistical analysis
- The basic aim is to illustrate system behaviour by taking raw data and displaying it in a graphical picture
- SPC is typically used to:
 - Help us understand the process 'right now'
 - Help us project into the future
 - Understand process capability
 - Identify and differentiate Special & Common cause variation
 - Identify where waste/defects occur in a system and help discover cause & effect

Raw data



Modelled with a
Control chart

Statistical Process Control (SPC) – 7 Basic Tools

Influenced by the teaching of Edward W Deming, Kaoru Ishikawa (aka, the father of quality circles) came up with **7 basic tools of quality** – *a fixed set of graphical techniques identified as being most helpful troubleshooting issues related to quality.*

- 1. Check (or Tally) Sheet** – form used to collect data at the location they are generated
- 2. Histogram** – an accurate representation of the distribution of numerical data
- 3. Pareto Chart** – individual values are represented in descending order by bars
- 4. Control Chart** – used to study changes in a process over time (guides: UCL / CL / LCL)
- 5. Scatter Diagram** – the pattern of data points suggests if correlation may be present
- 6. Run Chart** – helps to determine trends (or patterns) in a process
- 7. Fishbone Diagram (Cause and Effect)** – used to categorise possible causes of a problem in order to determine the root cause

In SPC, we need to define a representative sample and then model it. Our model illustrates how the population is now and helps us to figure out how it could be improved.

Frequency Distribution Tables

Often statistical modelling needs you to organise the data in a sample or population by sample size



A frequency table can be used for this purpose



This simple table organises the sample values by grouping them together



This information can be used to generate Bar charts, Pie charts, Histograms etc



As well as whole numbers, you can select ranges or categories

Samples

4, 1, 1, 2, 3, 4, 2, 2, 3, 5, 2, 3, 3, 3

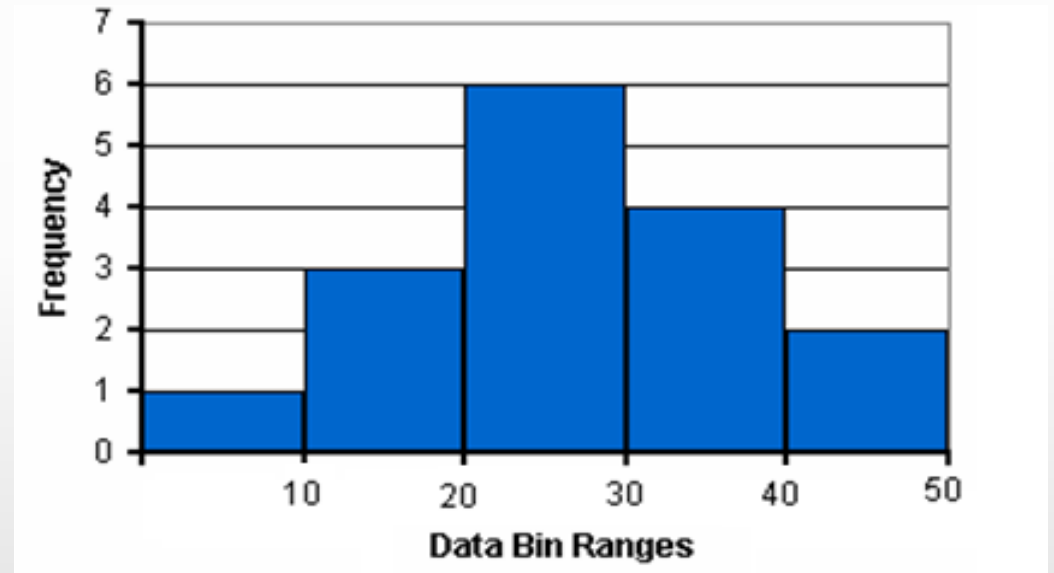
Sample Value	Frequency
1	2
2	4
3	5
4	2
5	1

Frequency Table

Histograms

A **histogram** is “a representation of a frequency distribution by means of rectangles whose widths represent class intervals and whose areas are proportional to the corresponding frequencies.” - *Online Webster's Dictionary*

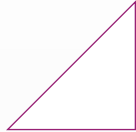
Data Range	Frequency
0-10	1
11-20	3
21-30	6
31-40	4
41-50	2



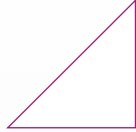
Bin ID (X axis)

The number on the join by convention identifies the left-hand bin with the right-hand bin starting at the next increment. So, for example, the first bin holds values 0-10 then the next bin starts at 11 and finishes at 20

Bar Charts and Histograms



Bar Graphs are good when your data is in categories (e.g. sales by region) especially when you want to compare them



But when you are measuring one thing (such as the number data sources for deliverable report) then a Histogram might be a better choice

The area under the Histogram represents the sample or population, with each bar representing a select segment

- Bars are kept the same width so the variance in each segment can be easily identified by height
- If a segment does not have any samples recorded in it then leave a gap (frequency = 0)

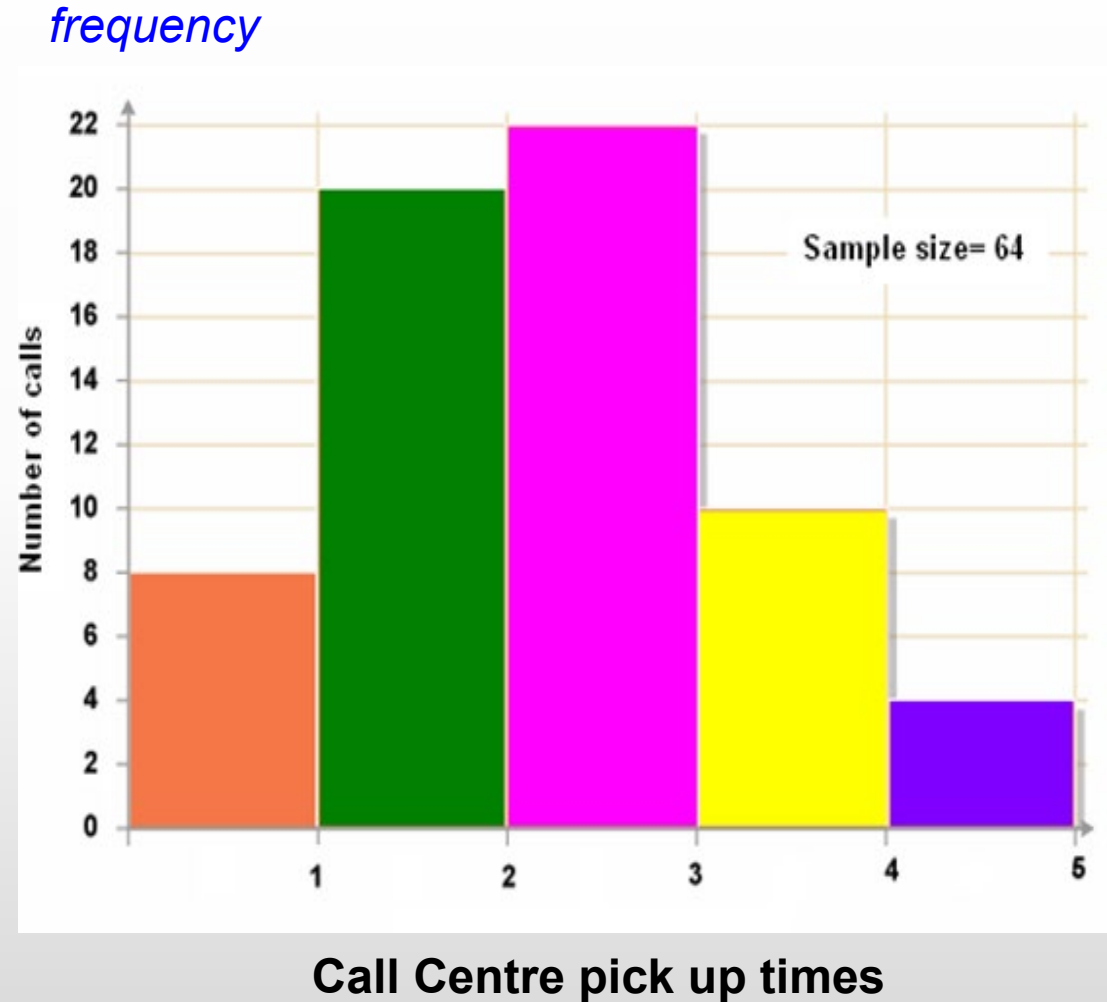
Histograms

The segments are all aligned (although you can have bins with zero contents)

The segment area represents the total sample percentage of that range

Frequency (number of samples that fit the range) is indicated by height (all segments are the same width)

The convention is that the starting number identifies the smallest value counted in that segment (so anything below 1 min is in the first bin)



Pareto Principle...

The **Pareto principle** (the **20–80 rule**, the **law of the vital few**, or **principle of factor sparsely**) states that for many events, roughly 80% of the effects come from 20% of the causes

Italian economist Vilfredo Pareto observed in 1906 that 80% of the land in Italy was owned by 20% of the population. He developed the principle by observing that 20% of the pea pods in his garden contained 80% of the peas.

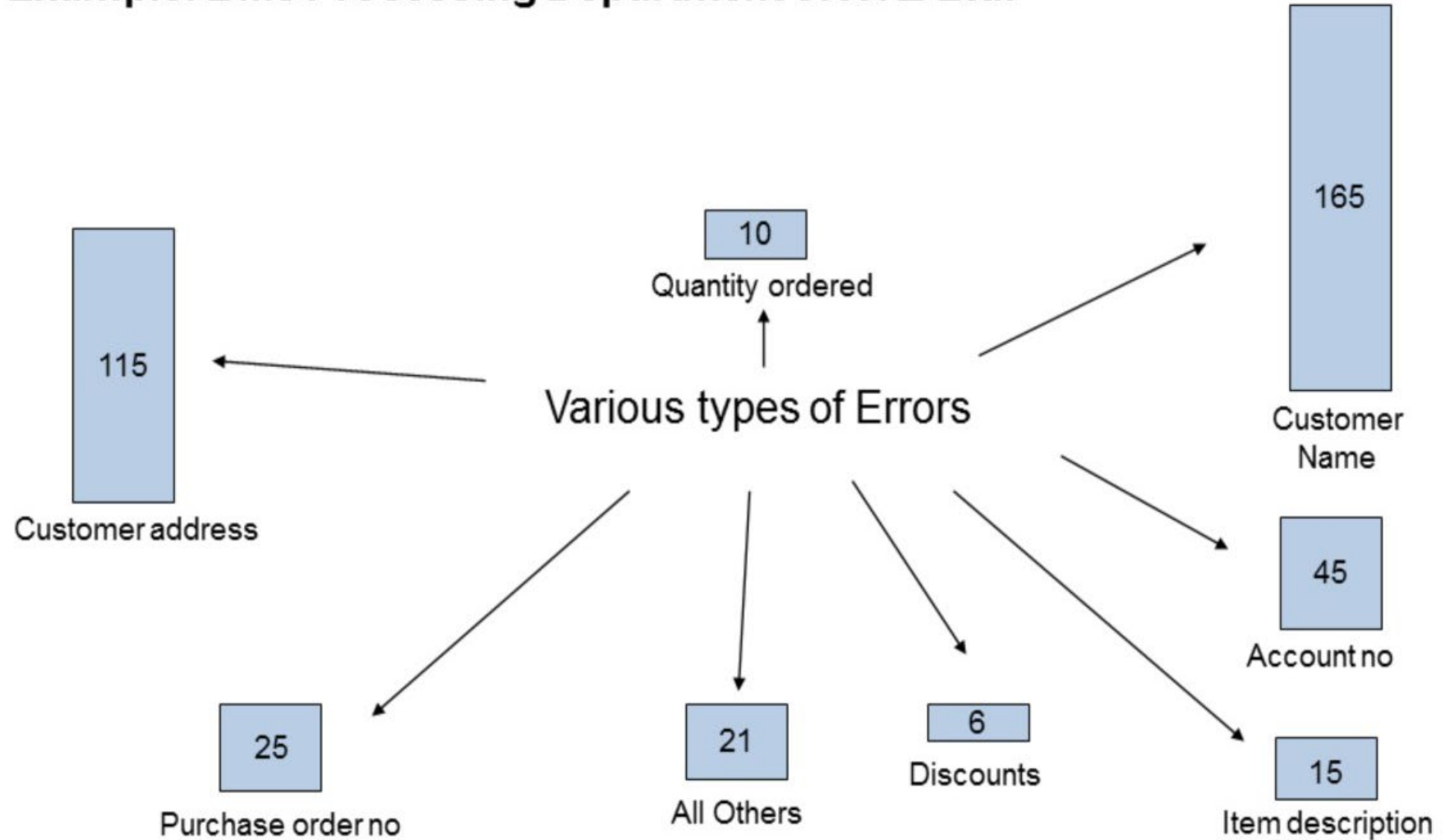


Pareto – An Example

Example: Bills Processing Department of XYZ Ltd.

About 400 invoices with errors have been collected. The types of error have been determined.
[Note that 21 individual errors have been combined at the end]

This information here is then placed onto a Pareto Chart – see next slide.



Pareto – An Example (contd.)

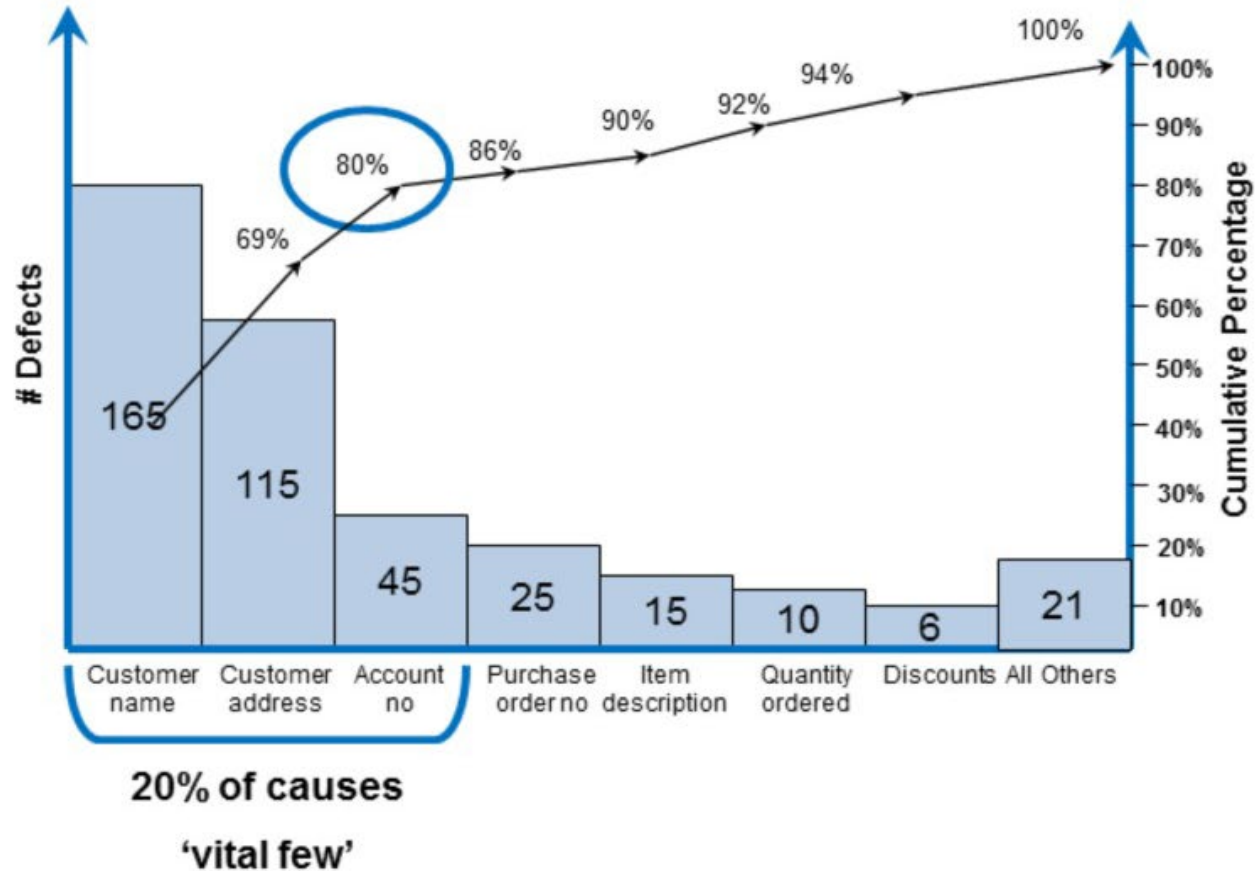
ADVICE:

Focus first on the largest bar – this could reduce errors by 40% (not bad for a GB improvement).

Having completed that move to the next one, etc.

Another benefit of the Pareto is that it can be used as a before and after picture to demonstrate improvement at Control.

Example: Bills Processing Department of XYZ Ltd.

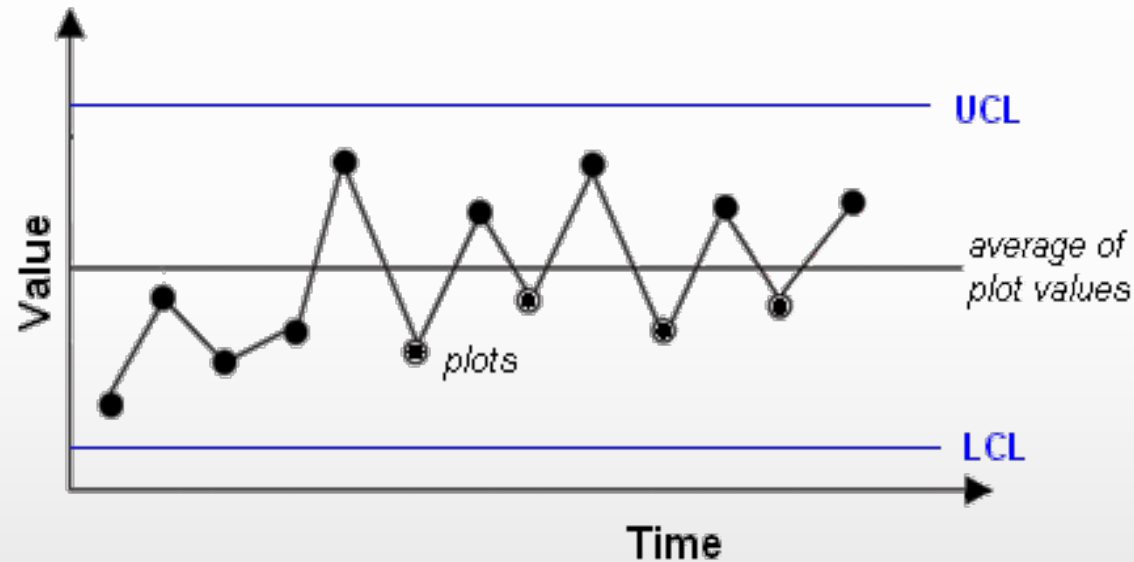


A few points to remember:

- The split isn't always exactly 80 and 20 in real data, but the effect is often the same
- Pareto charts can be used to further drill down on specific causes

Understanding Control Charts

A control chart is a graph used to study how a process changes (varies) over time. Data are plotted in time order



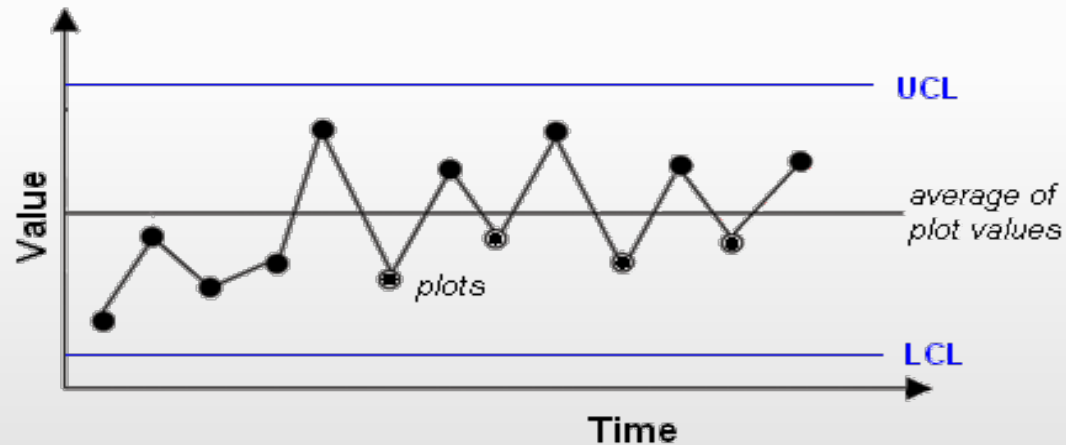
A control chart monitors on-going process performance by measuring the output of a process. It identifies how well it is performing and will show the performance of the process over time. It can be used to demonstrate that your improvements were sustained.

All control charts share 3 attributes

A **centre line** representing an average value of the selected data characteristic

An **Upper Control Limit** (UCL) representing a statistically determined upper boundary of 'acceptable' variation

A **Lower Control Limit** (LCL) representing a statistically determined lower boundary of 'acceptable' variation



The values of the UCL and LCL are selected so that most of the common cause variation (typically 99.73%) lies between them (as shown in the graphic). Thus, if you sample your process and you get a value outside of the *Control Limits*, you can suspect that there is a **Special** (or '**Assignable**') cause behind it which you must then investigate.

Two Types of Process Variation

Common Cause variation

- Variation due to the natural variation that is inherent within a process
- If all variation is due to '**common causes**', the result will be a **predictable** or **stable** system

Variation is the “Voice of the Process” – learn to listen to it and to understand it

Most processes have both types of variation – Control Charts can help identify them

Special Cause variation

- Additional variation with a specific external cause
 - A more capable operator reduces variation
 - Electrical spark from elevator causes a cutting machine to reset
- If some variation is from '**Special Causes**', the result is an **unpredictable** or **unstable** system
- Remove special causes before using statistical analysis (usually a quick fix)

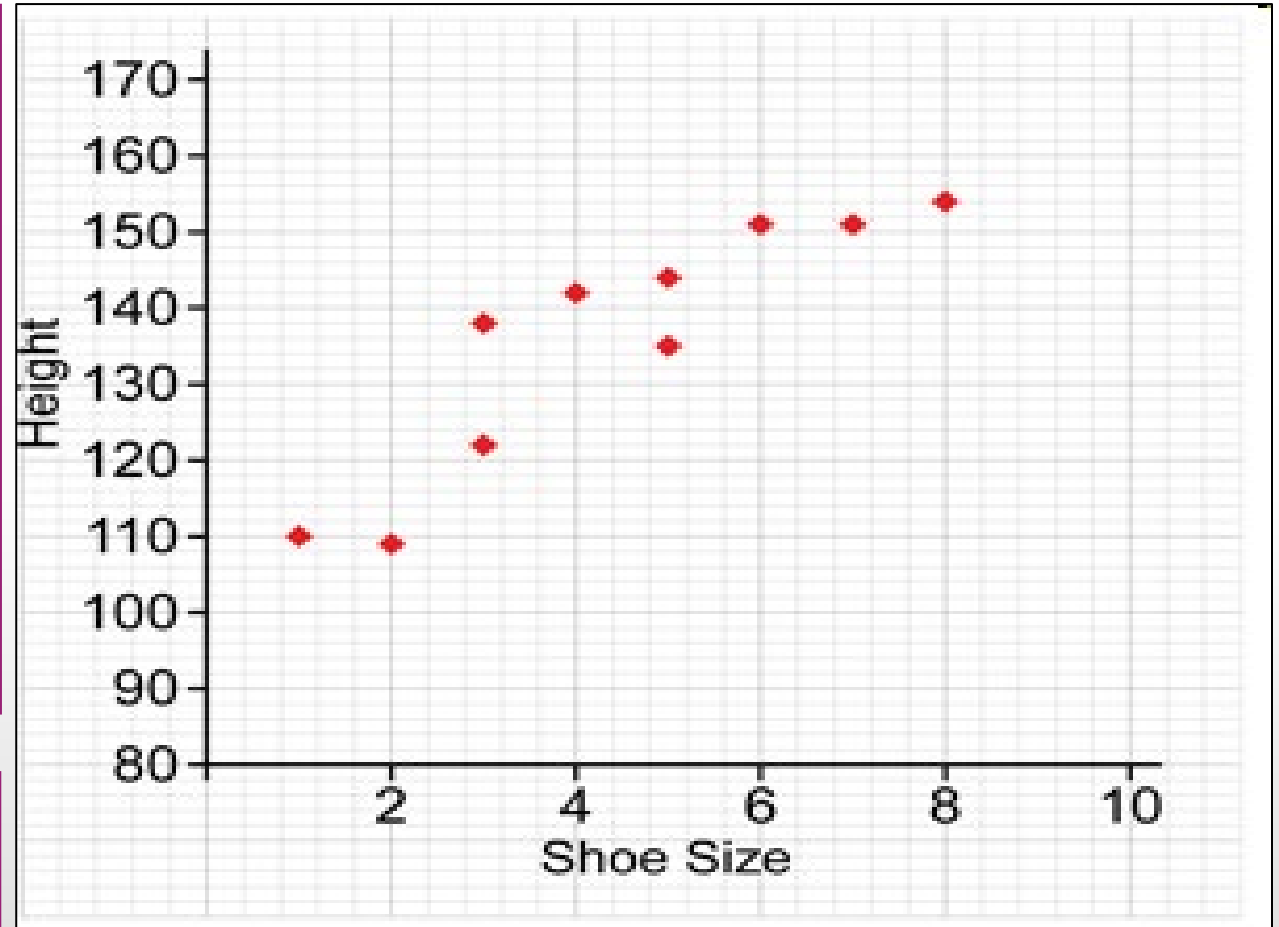
Scatter diagrams

Purpose: To identify the correlations that might exist between a quality characteristic and a factor that might be driving it.

Used to map data points between two axis

- X: horizontal
- Y: vertical

Scatter Diagrams are used to indicate if one variable is linked with another (if there is a **correlation**)



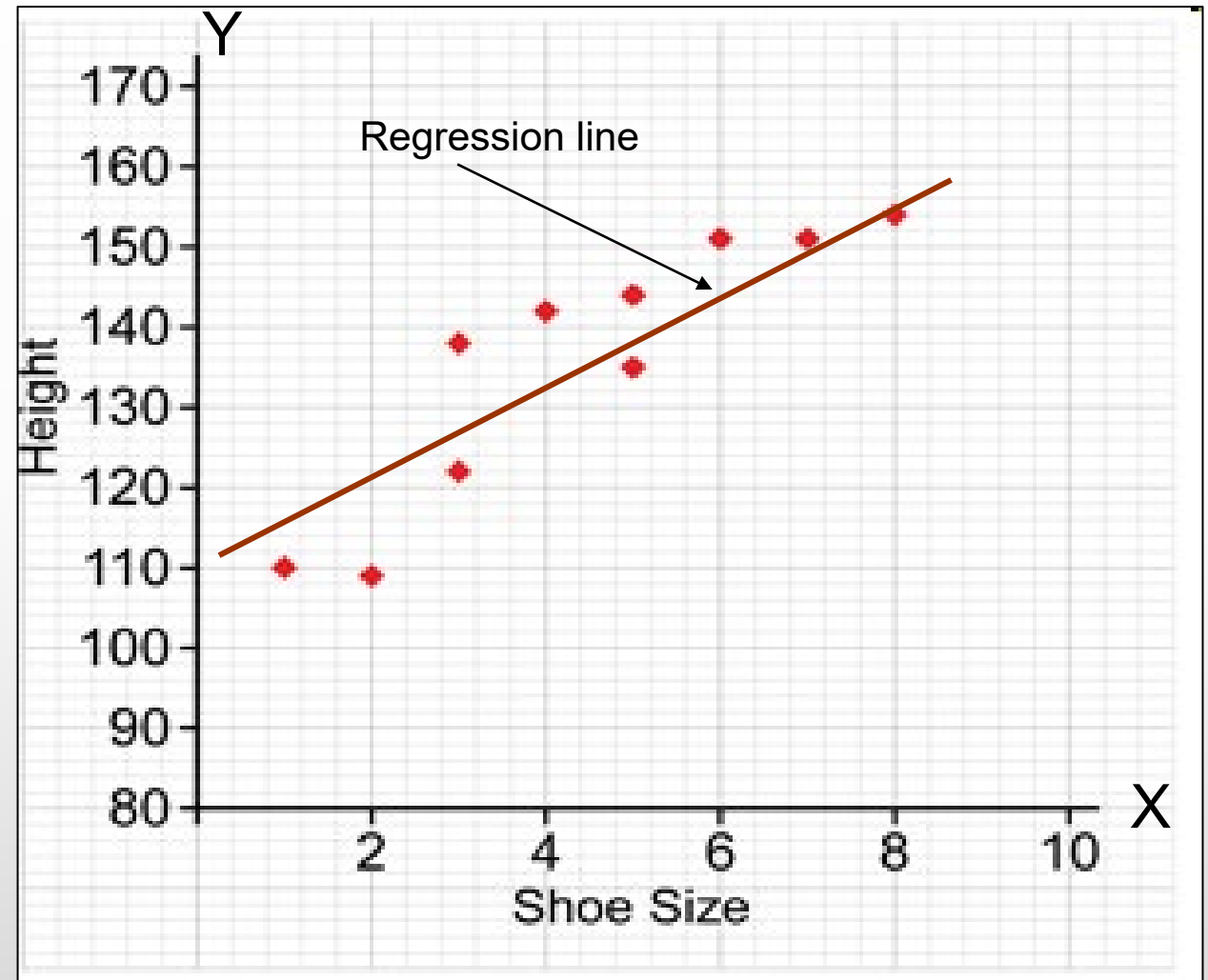
Do you think that a person's height and shoe size could be related?

Correlation and Regression

Using Linear Regression, draw a line through the data points so that 50% of the plots are on either side of the line – there needs to be an obvious direction to draw the line

We can talk about '**strong correlation**' where the plots are all close to a line – and '**loose correlation**' where the lines are more widely scattered

Regression lines can be **positive** or **negative** and cut the Y axis at the **intercept**



Correlation and Causation

Linear regression can be used to investigate two variables in two ways:

- Are the variables related in some way? (do they alter in a way that seems linked?)
- To make a forecast about the state of one variable given the other

In L6S, we are often looking to see if an input variable (an 'X') has an effect on an output variable (a 'Y') – however, we cannot say absolutely that just because two variables seem to have a strong correlation, that the change in one, caused the change in the other (there may be a common cause)

Correlation does not prove causation

Run Charts

A run is defined as one or more consecutive data points on the same side of the median

A run could have a single point, or many points chart

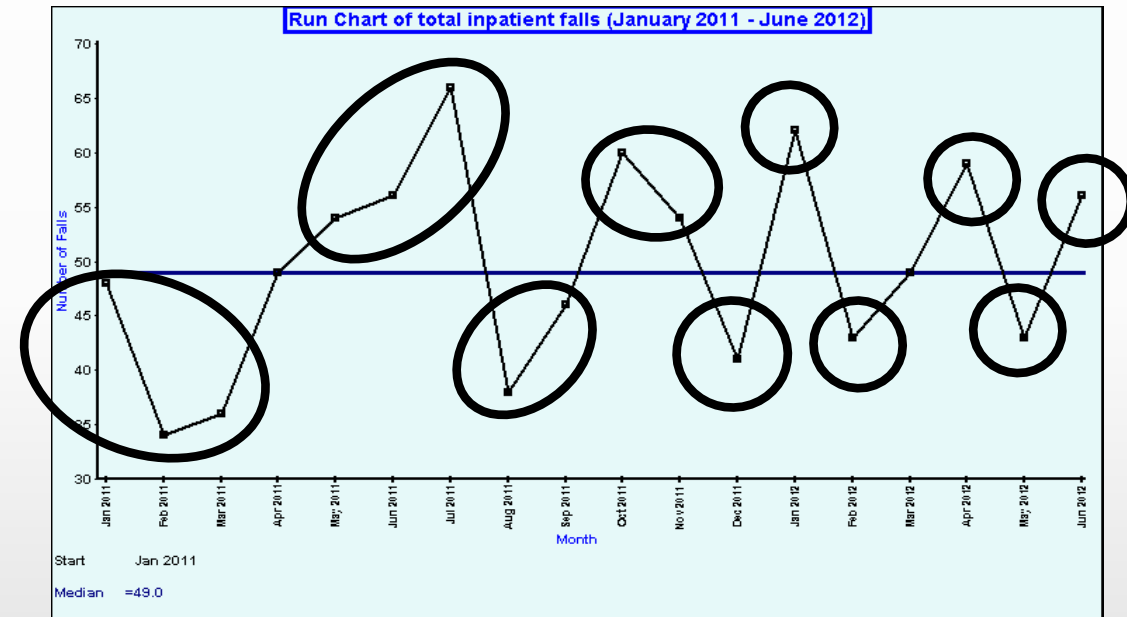
Help to identify trends in data

Link changes in the process to points in time

Do not need the normal distribution

Often used in the Control phase to track process performance

In this case the acceptable values are often 'hard wired' onto the chart



In this chart, there are 10 runs.

- Notice that the runs exclude any points that are on the median line.

Measurement & Analytical Tools and Techniques

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- Statistical Process Control & Graphical representations
- ***Process Efficiency***
- 5 Why's
- Fishbone (Ishikawa) Diagram

Identifying Process Efficiency

There are three common ways of describing the efficiency of a process:

Yield

- How many pieces are within the customer's specification limits?
- Usually expressed as a percentage of the total batch

DPMO

- **D**efects **P**er **M**illion **O**pportunities
- In a million defect opportunities how many defects will actually occur?

Process Sigma

- A way of forecasting how likely our process is to meet the customer's requirements – the higher the Sigma number, the more successful we are
- The value of Sigma is derived practically from the variation within a process

Process Capability

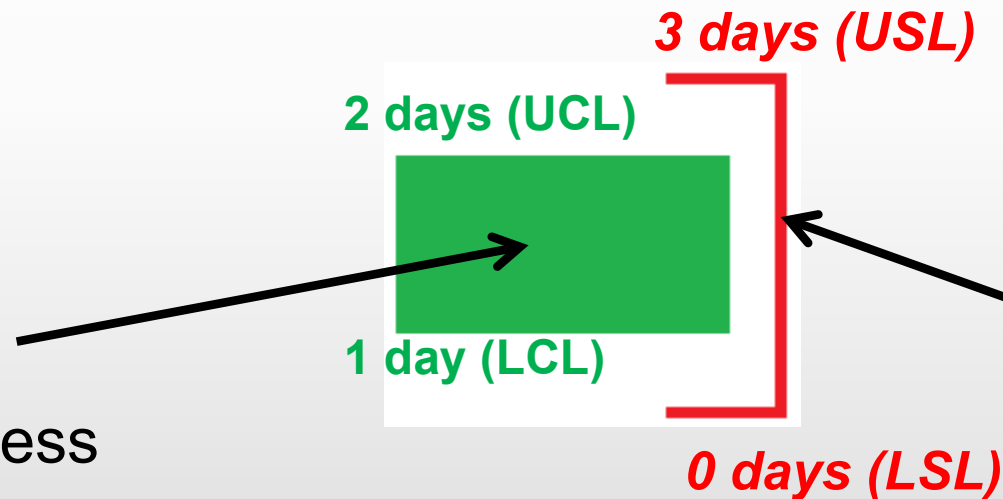
All processes have variation in their outputs

Customers will only accept a certain range of variance (tolerance) from a supplier

The **capability** of a process is a measure of its ability to deliver within customer tolerance

Process Variation

The maximum and minimum values created by the process



Customer Tolerance

The maximum and minimum values they will accept from a process

Example: Customers expect a response to a question within 3 days. When measured, the company responded to all questions within 1-2 days. This is therefore a **capable** process

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5 Whys

How do you use the 5 Whys?

- By repeatedly asking the question “Why” (five is a good rule of thumb), you can peel away the layers of symptoms which are disguising the *root* cause(s) of a problem



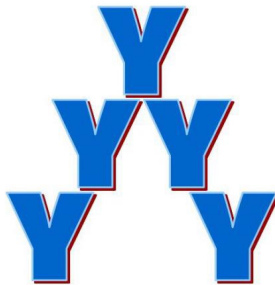
What are the benefits of using 5 Why?

- Help identify the *root cause* of a problem
- Determine the relationship between different root causes of a problem
- One of the simplest tools – easy to complete without statistical analysis

When Is 5 Whys Most Useful?

- When problems involve human factors or interactions

5 Whys



Examples of 5 Whys

Business

Why are our sales down?

- Nobody's buying our product

Why is nobody buying?

- Because our delivery has a poor reputation

Why do we have a poor reputation?

- Because we are always late

Why are we always late?

- Because we do not have enough trucks

Why do we have too few trucks?

- Because we underestimated demand for our product

Technical

Why is there water on the floor?

- Because a pipe in the roof split

Why did it split?

- Because the water in it froze

Why did the water freeze?

- Because the pipe is near an air vent and sometimes cold air blows over that section

Why was the pipe routed there?

- The installers did not check for potential drafts

Why did they not check?

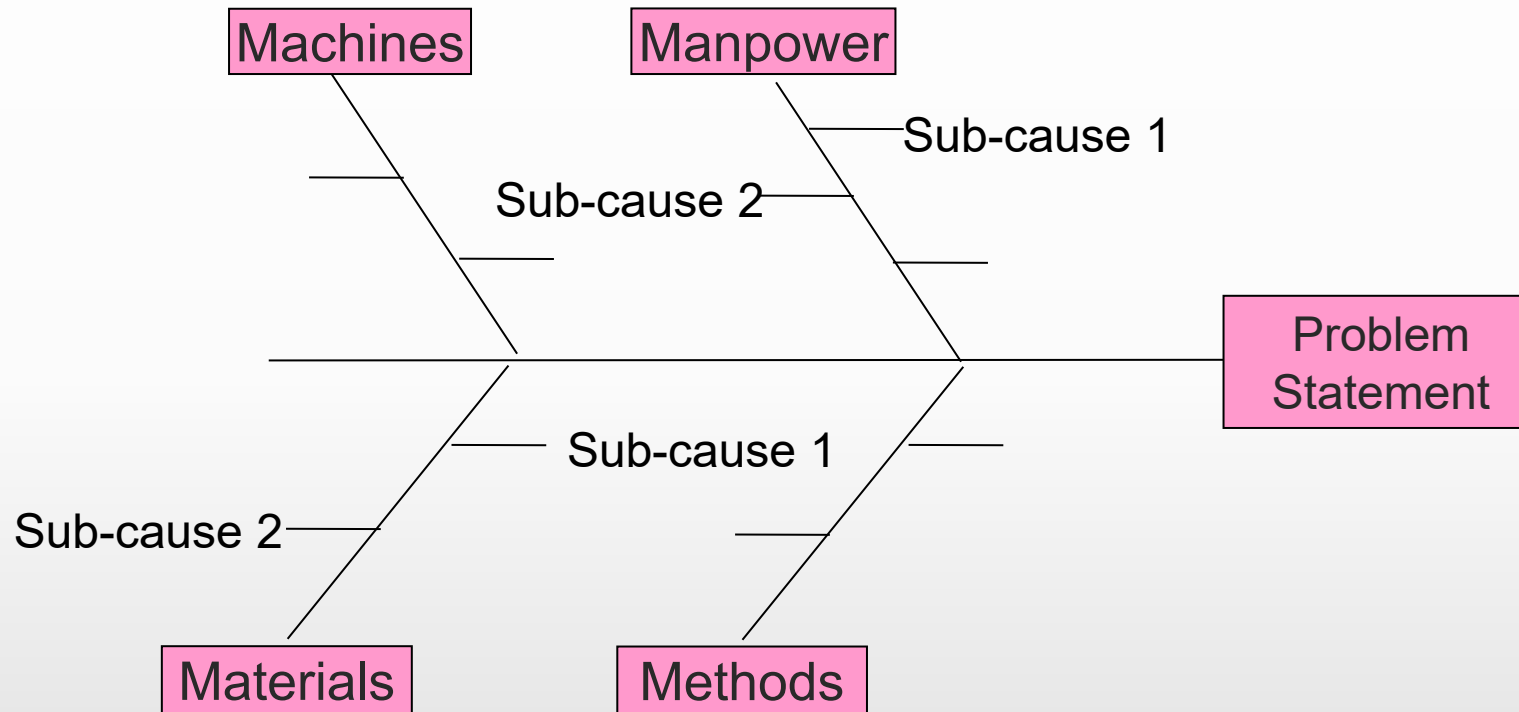
- Because their training did not include this

Measurement & Analytical Tools and Techniques

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- ***Fishbone (Ishikawa) Diagram***

Fishbone (Ishikawa) Diagram

This is a powerful tool used to identify, record and visually represent the possible causes of a problem

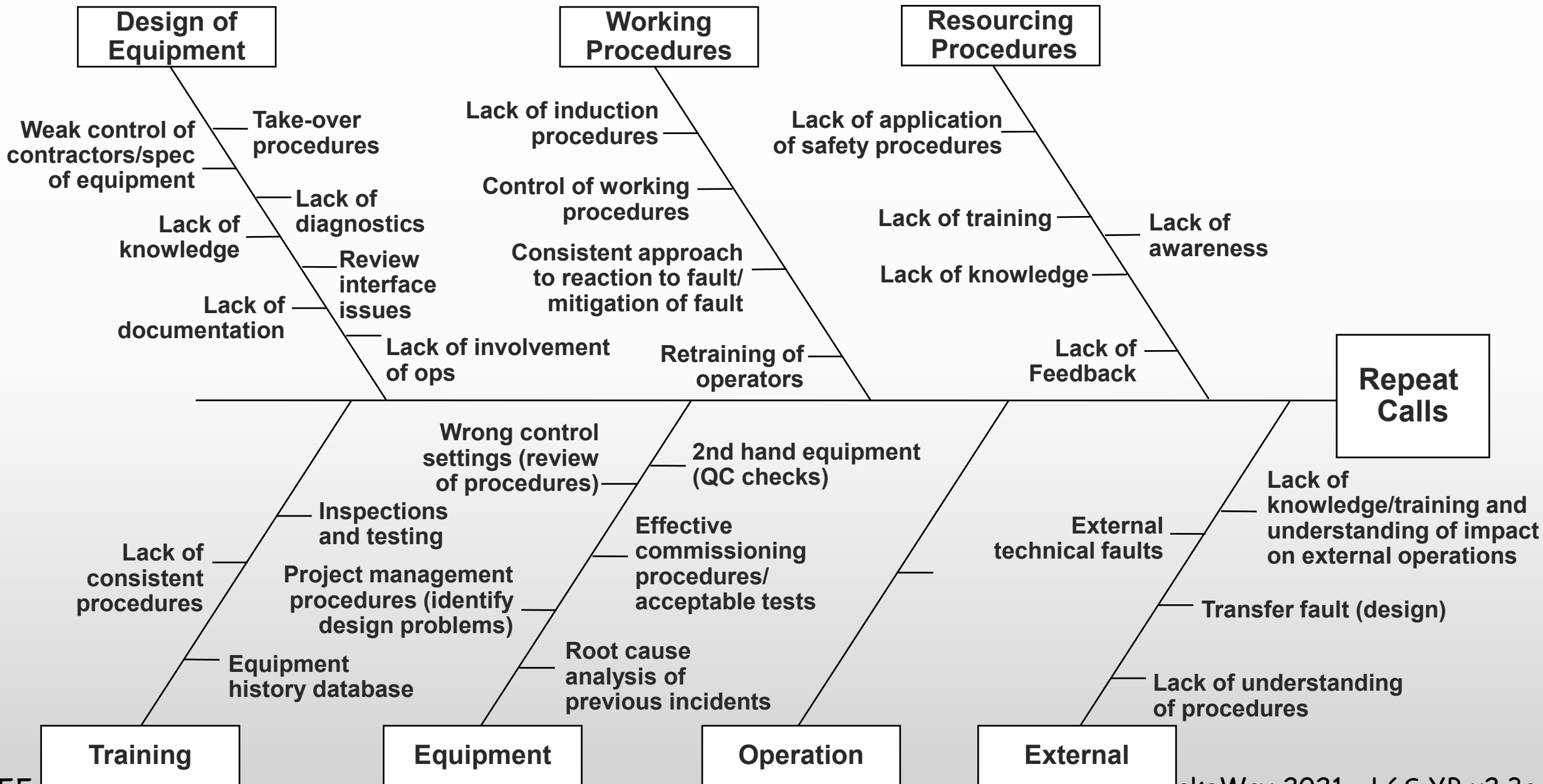


Develop initially as a small project team, but then develop it further and validate the causes with input from key operational people – using for example, the 5 whys technique

Fishbone digs down to the real problem. It breaks down what can appear to be an impossible issue, into smaller, more easily handled chunks.

The Fishbone can also be used to test or arrive at a solution

A cause and effect diagram to probe root causes of repeat calls to a utilities call centre



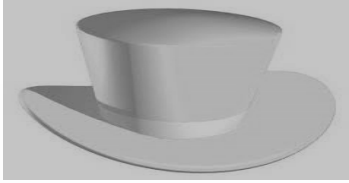
Review Questions

- What is important in the measurement system?
- What is important in choosing a sample size?
- What different methods can be used to collect a representative sample?
- What do the *Mean*, *Median* and *Mode* estimate?
- What do we use to describe the *spread* of data?
- What does a *Pareto Chart* show?
- What are the two types of variation in a process?
- What are the 3 lines that a control chart shows?

Solution Tools and Techniques

- ***Brainstorming – The Six Thinking Hats***
- Fishbone Diagram
- Prioritisation Tools: Pugh Matrix
- 5S
- Mistake Proofing: Poka Yoke
- SMED / Quick Changeover
- Piloting the Solution
- Standardisation and Documentation
- Communications and Training
- Solution Validation

Brainstorming – The Six Thinking Hats



White Hat – Obtain and record available information and identify further information that may be needed (be objective!)



Red Hat – Using intuition and emotion, it allows for the expression of feelings without justification or prejudice



Yellow Hat – Taking a positive view, look for benefits to support a position (even the critics are encouraged to do so)



Black Hat – This relates to caution (risk assessment) and it is used for critical judgment (be careful of overuse!)



Green Hat – This is for creative thinking and so it is used to generate new ideas (put on the thinking cap!)



Blue Hat – This is about process control of other hats; it invariably summarises, concludes and draws the conclusion

Solution Tools and Techniques

- Brainstorming – The Six Thinking Hats
- Fishbone Diagram
- ***Prioritisation Tools: Pugh Matrix***
- 5S
- Mistake Proofing: Poka Yoke
- SMED / Quick Changeover
- Piloting the Solution
- Standardisation and Documentation
- Communications and Training
- Solution Validation

Example Pugh Matrix

	Solution/Ideas				Weighting
Criteria	A	B	C	D	
Meets food hygiene standards	+	+	S	S	4
Low maintenance	S	-	S	S	2
Quick to implement	+	-	S	-	1
Simple to operate	-	-	S	+	3
Positives (weighted score)	+5	+4	0	+3	
Negatives (weighted score)	-3	-6	0	-1	
Weighted score	+2	-2	0	+2	

Prioritisation Tool: Pugh Matrix

What it is

- A weighted matrix which compares solutions/ideas against set criteria
- Allows a group to compare possible solutions and develop or improve them at the same time
- One solution is chosen as the 'standard' (benchmark/baseline) and then the other solutions are contrasted with it
- Comparison leads to identification of ways to improve or extend



How to...

1. Agree solutions/ideas, criteria and weighting values
2. Choose the 'benchmark' solution
3. Compare and contrast each solution with the benchmark deciding if it is...
 - The same (s)
 - Better (+)
 - Worse (-)
4. Calculate the weighted sums (+ & -)
5. Investigate how the solutions can be improved by adopting/combining features – possibly resulting in a 'hybrid' solution
6. Re-run against a different 'benchmark' as necessary

When to Use a Decision (Pugh) Matrix

- When a list of options must be narrowed to one choice
- When the decision must be made on the basis of several criteria
- After the list of options has been reduced to a manageable number by list reduction
- Typical situations are:
 - When one improvement opportunity or problem must be selected to work on
 - When only one solution or problem-solving approach can be implemented
 - When only one new product can be developed
 - When you wish to explore combining several suggestions

Solution Tools and Techniques

- Brainstorming – The Six Thinking Hats
- Fishbone Diagram
- Prioritisation Tools: Pugh Matrix
- **5S**
- Mistake Proofing: Poka Yoke
- SMED / Quick Changeover
- Piloting the Solution
- Standardisation and Documentation
- Communications and Training
- Solution Validation

The Steps of 5S

Seiri (Sort): Clean up and sort all material, equipment and unnecessary information

Seiton (Set in Order): Make necessary input available in a logical order and available

Seiso (Shine): Ensure any input is ready to be used

Seiketsu (Standardise): Identify standard activities and practices and means to monitor them (eg inspections)

Shitsuke (Sustain): Introduce and support a mind set of continuous improvement



A place for everything and everything in its place, clean and ready to use

What is 5S?

The 5S is a simple tool to

- introduce discipline in the organisation of physical space and processes
- improve the environment
- raise morale
- increase workplace safety
- improve productivity and response times
- impress your customers
- highlight where to remove waste and non value add activities



Improve

- Identify and Select Solutions
 - Brainstorming
 - Fishbone Diagram
 - Prioritisation Tools: Pugh Matrix
- Implementing Solutions
 - 5S
 - ***Mistake Proofing: Poka Yoke***
 - SMED / Quick Changeover
- Piloting the Solution
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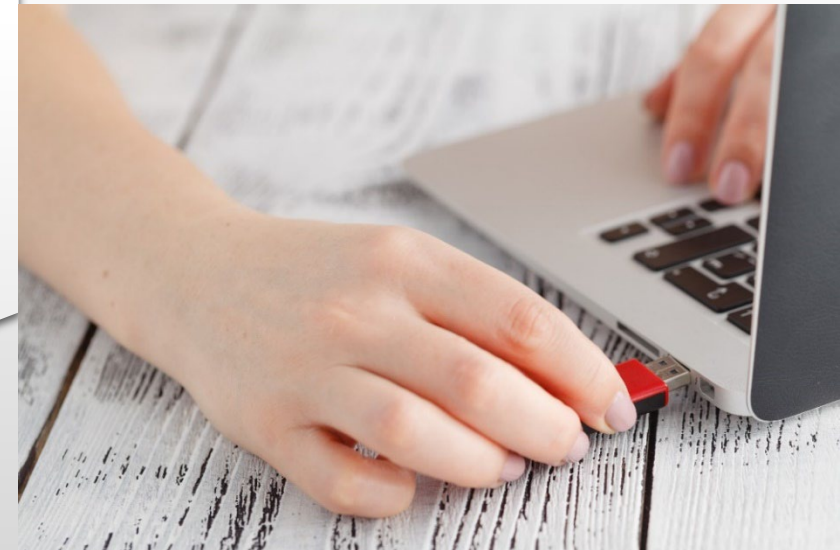
Mistake Proofing: Poka Yoke

Poka Yoke can be translated as “**Mistake Proofing**”

The objective was to eliminate errors before they occur, rather than finding and fixing them

The ideal Poka Yokes are:

- Inexpensive
- Simple and easy to implement
- Developed by every employee



Two Main Types of Poka Yoke

The original objective was to eliminate errors and fix them before they occurred. However, this purpose has changed somewhat as the Poka Yoke concept evolved

Many people split Poka Yoke into two main types:

- **Shut out type:** Physically preventing an error being made (preferable)
- **Attention type:** Highlighting that an error has been made (acceptable)



Improve

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SMED / Quick Changeover

- ❑ **SMED (Single Minute Exchange of Die)** a system for dramatically reducing the time it takes to complete equipment changeovers.
 - ❖ The faster the changeover times, the less downtime of equipment
 - ❖ The essence is for the **SMED** system to convert as many changeover steps as possible to “external” (those that can be performed while the equipment is in operation), as well as simplify and streamline the remaining steps
 - ❖ The **Single Minute** stands for a **single** digit **minute** (i.e., less than ten **minutes**)
- ❑ It was originally developed by Shigeo Shinjo to improve die and machine tool setups
- ❑ Quick changeover is the term used for non-manufacturing process changeovers.
- ❑ SMED/Quick Changeover also covers new setup.
- ❑ Quick changeover principles can be used and applied in almost any operation or process



<https://www.youtube.com/watch?v=UIIGI3laGAo>

Solution Tools and Techniques

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Piloting the Solution

Piloting your solution is a recommended step in the Lean Six Sigma process



It is a way to work out the potential issues in a new process and should help make implementation on the new process successful.

It is also used to verify root cause



There are many different ways to perform a pilot



Any pilot should be well planned out, have a defined objective and results should be measured



Types of Pilot Programmes

Proof of concept

Trialling one part of the solution

- Don't forget to use any lessons learnt where necessary

Off-line

- This is performed outside of the key manufacturing or service line in a test environment – useful when process interruption is very expensive and/or disruptive

Specific times

- The pilots are performed during specific windows of time - useful because they allow comparison with the standard process

Customer or item related

- Piloting with specific customers or items

Specific location

- One facility that runs the same processes as others can be used as a test facility – helps to shield the customer from process

Specific aspects of the solution

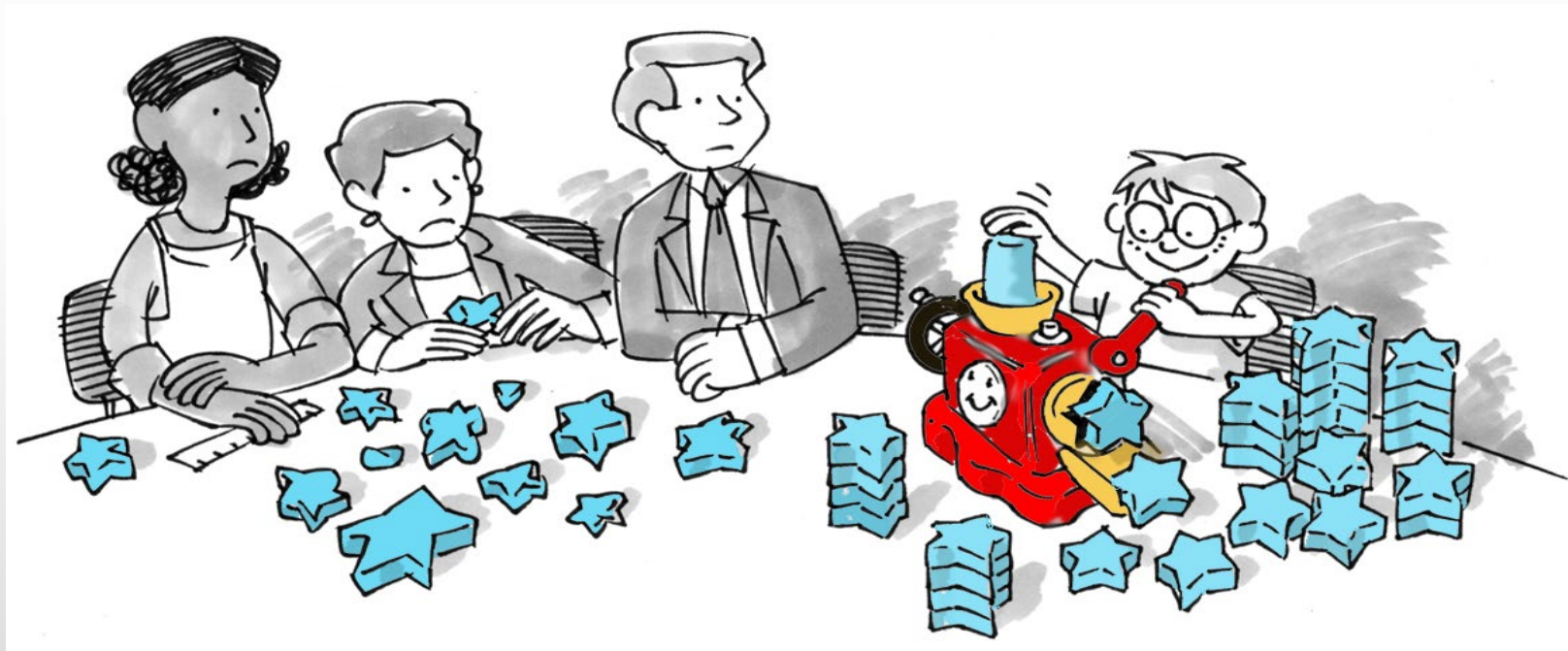
- Certain aspects of concern can be tested in a pilot solution

Solution Tools and Techniques

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Standardisation and Documentation: Core Principle

‘Nothing happens on a reliable, sustained basis unless we build a system to cause it to happen on a reliable, sustained basis.’



Gather technology and process skill in written form, to make it easier to do the work

Standardisation Goals

- **Goals:**

- Making sure that important elements of a process are performed consistently to meet requirements
- Changes are made only when data shows that a new alternative is better
- Documentation is key
 - **Making sure documentation is up to date and used – encourages on-going use of standardised methods**



Standardised Work

Documented procedures that capture best practices (including the time to complete each task)

The One Best Way

Clear, concise and easy to understand

Pictorial highly recommended

OTGIs

Must be 'living' documentation that is easy to change

Encourage team to discover a better 'one best way', and then apply it

On The Ground Instructions (OTGIs)

Follows on from process mapping

Sometimes referred to as 'SOP' (Standard Operating Procedures) or 'Work Instruction'

Process maps describe what is done – OTGIs explain how to do it

Ideally, OTGIs define the 'one best way' to perform a task, leading to *Standardised Work* (and thus reducing variance)

Pictures are preferable to written instructions



SOPs and OTGIs

Some people differentiate between SOPs and OTGIs – here is a comparison between the two

Standard Operating Procedures

A formal approach to documenting the 'one best way'

Defines a standard way to perform a task

Often forms part of an official document

Can be useful in compliance or regulated environments

To change often requires a formal change control procedure

On The Ground Instructions

An informal approach to documenting the 'one best way'

Defines a standard way to perform a task or an instruction to be followed

Usually written within the process as the need is identified

Helps the team define the 'One Best Way' as an ongoing series of actions

Changing OTGIs is done when the team recognises a new 'One Best Way'

Standardisation Benefits

Standardisation helps us compete more successfully in the marketplace by providing:

- Increased reliability
- Reduced costs
- Improved employee performance
- Increased safety
- Processes that remain in control and consistently satisfy customers
- Continuous improvement
- Flexible practices that allow for quick response to customer needs

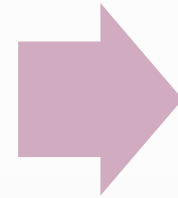
Standardisation = Standard practices and procedures

Solution Tools and Techniques

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Communications and Training

When you have completed the documentation, you need to make sure that everyone using a common process is trained in the new methods



Even experienced employees need to be trained in the new methods

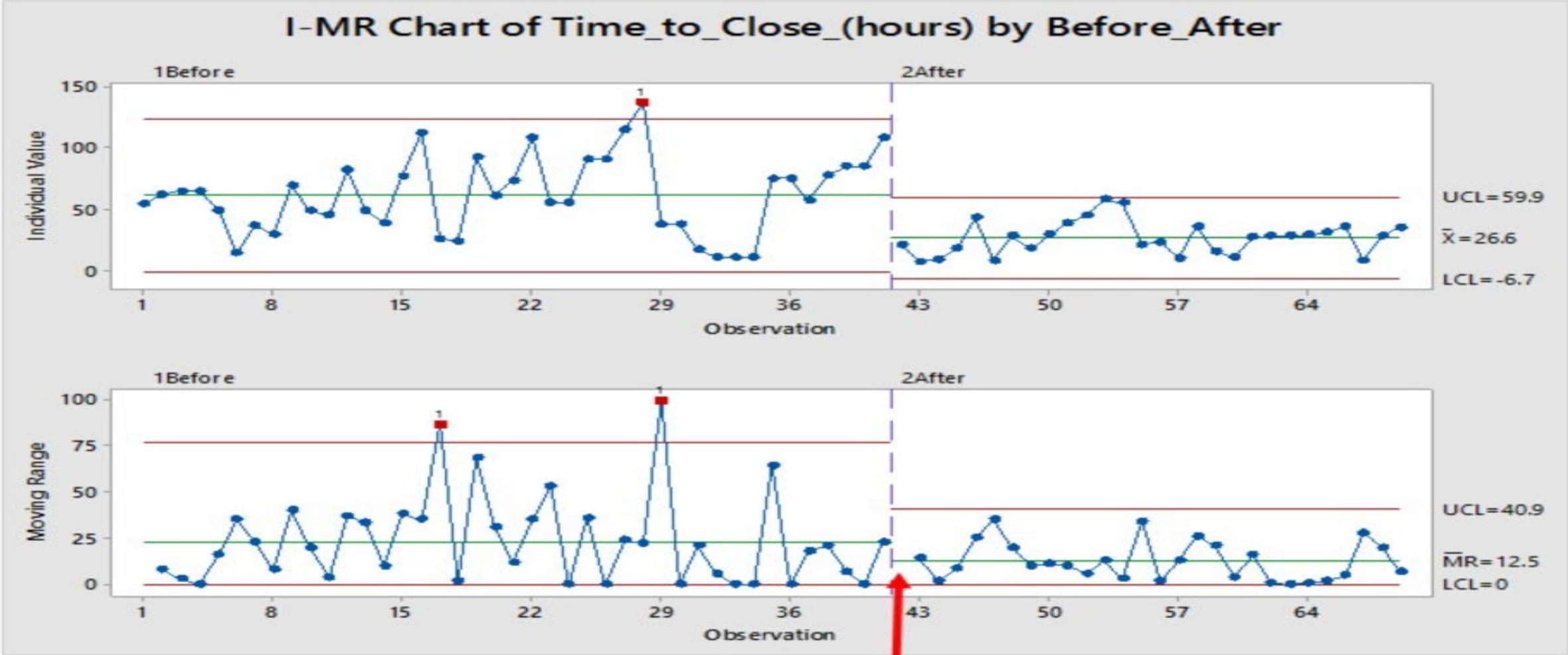
Plan the training well as this is the secret of a successful implementation

Standardisation ensures a realisation of the benefits obtained by improvement, by establishing supportive systems and structures

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Solution Validation – Graphical Example



Solution implemented

Review Questions





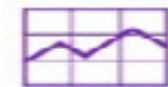
- Can you explain the benefits of using the *Six Thinking Hats* as a brainstorming technique?
- Which tools can help with selecting and/or comparing improvement ideas?
- Why should you run a pilot?
- What is *Poka Yoke (Mistake Proofing)* trying to do?
- Why is it important to measure the improved process?
- Before closing the project, what should be handed over to the *Process Owner*?

Pass on the good news



A Quick Review...

DMAIC – A SNAPSHOT

				
DEFINE	MEASURE	ANALYSE	IMPROVE	CONTROL
<i>What exactly is the issue and can we deal with it</i>	<i>Quantify the current state (determine the baseline)</i>	<i>Identify the cause of the problem</i>	<i>Implement and verify the solution</i>	<i>Maintain the Solution</i>
Aim: Clearly state the specific business problem, goal, potential resources, project scope and high-level project timeline	Aim: Understand the "As Is" state – how the process is performing and what the magnitude of the problem is	Aim: Get to the root cause(s) of the problem, flesh it out, and derive the "To Be" or "future state"	Aim: Determine a solution which will solve the identified problem	Aim: Ascertain that the action improvements carried out in the <i>Improve</i> phase have worked and are well-maintained
<i>What exactly is the issue?</i> Problem/goal statement Business Opportunity Project documentation - other <i>Dealing with the issue</i> Project charter Project team / Team charter Project management / Project plan Process Definition - SIPOC / High level 'As Is' Process Map Stakeholder Management (inc communication plan) VoC - CTQ / Customer requirements / Customer/Feature diagrams / Kano	<i>Quantify the current state</i> Operational definitions Data collection method/plan Data collection form Sampling (and frequency) <i>Is data representative/relevant?</i> SPC / KPIs Spaghetti diagrams Pareto Charts Gemba walk / Process stapling Histograms <i>What is current status of process?</i> Establish baselines Current VSM (As Is) Process Capability (Cp / Cpk) Yield / DPMO / Process Sigma Quick wins identified/proposed	<i>Move from subjectivity to fact</i> SPC - Analyse Identified/tested root causes Brainstorming Select probable root causes Validated root causes 5 Whys / Fishbone Affinity Diagrams Lean process analysis Regression Analysis Correlation Tools <i>Impact of change on Process</i> VSM target (To be) Process capability (To be) FMEA	<i>What solutions are available and what is best for the process?</i> Consensus tools Problem solving 5S / Poka Yoke Brainstorming <i>What is the cost/benefit/risk?</i> Assessment criteria Root cause analysis / FMEA Statistical data analysis <i>Implementing the 'fix'</i> Implementation schedule/events Pilot plan / Action plans OTGIs Validation of benefits Control plan	<i>Has it been embedded in BaU?</i> SPC Visual management Continuous kaizen, 5S etc Standard Operating Procedures Updated working practices Training manuals / Training plans <i>How will progress be monitored?</i> Visual management Process control systems <i>Was the project goal achieved?</i> Benefit measurement Key Performance Indicators (KPIs) <i>Close the project</i> Project report (inc lessons learned) Team celebration / Team disbanded <i>Continuous/Ongoing Improvements...</i>

What next?



**You can only attend with a proposed
Green Belt improvement project**

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To improve supporting you better, please give reviews

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International Lean Six Sigma Institute

This is to certify that

Candidate Name

Has satisfactorily completed the requirements prescribed by the
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ST Mishari

Director of Certification

International Lean Six Sigma Institute

"That's all folks!"



Yellow Belt Exam



Personal
study
time

All the best...