

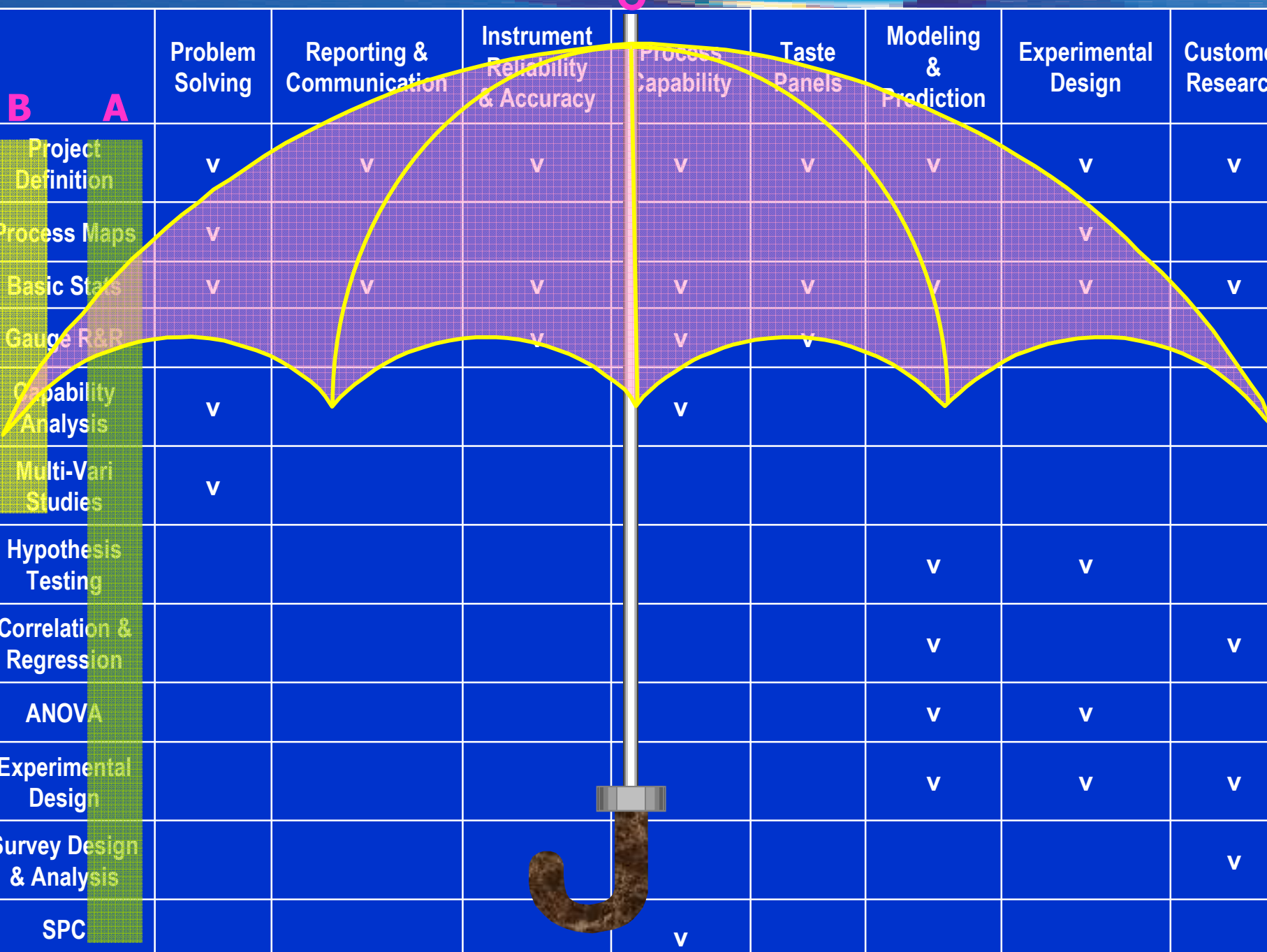
# Assessment & Evaluation of a Lean Six Sigma Program



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# Background

- **Company facing an increasingly dynamic and competitive national and global industry.**
- **The routine use of statistics within the company was recognised as an essential core capability**
- **Primary objectives of the program:**
  - *to build the capability to better utilise statistical tools on a day-to-day basis*
  - *to utilise best practice methods in technically based projects*
  - *for performing relevant research.*



# Program

- 15 modules (3 – 4 hr sessions) covering 13 topics
- Trainees allocated according to perceived need in performing their business function

<i>Module</i>	<i>Groups</i>
Intro: Six Sigma & Lean	A+B+C
Process Characterisation	A+B+C
Exploratory Data Analysis	A+B
SPC – Basics	A+B
Gauge R&R	A+B
Multi-Vari Studies	A+B
Process Capability	A+B

<i>Module</i>	<i>Groups</i>
Correlation & Regression	A
Hypothesis Testing & CI's	A
ANOVA	A
Experimental Design I	A
Experimental Design II	A
SPC – Advanced	A

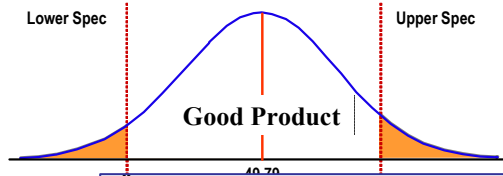
# Training Materials

## The Normal Distribution

Imagine a process producing a product that requires a specification of  $49.75 \pm 0.5$ . Assume

*process mean = 49.79mm and stdev. = 0.4mm*

Assuming the distribution is approximately normal we can represent the situation as follows:



### 3. → Separate Analyses of Data

3.1 → Often it is useful to be able to look separately at data originating from different sources as is the case here. In order to do this Minitab requires identification labels such as those we have used in column 2 indicating the types of cheese. Separate analyses are obtained by referring to these labels in sub-commands attached to Minitab commands. The sub-commands are initiated using the *semi-colon* and concluded using a *full stop*.

→ The **DESCRIBE** command can be used to determine descriptive statistics for the bolt block weight data, for each supplier as follows.

→ `MJT> DESCRIBE C1;`

→ `SUBC> BY C2 ;`

`STAT> Basic Statistics > Display Descriptive Statistics`  
(use the *by* option)

→ Determine the following:

→ **Cheddar:** →  $\bar{x} = \dots$ ;  $s = \dots$ ; IQR =  $\dots$

→ **RedFat:** →  $\bar{x} = \dots$ ;  $s = \dots$ ; IQR =  $\dots$

→ **Skim:** →  $\bar{x} = \dots$ ;  $s = \dots$ ; IQR =  $\dots$

Power-point slides provided basic material  
Supplemented by web-based articles & notes.

### Human Behavior Patterns

Figure 1 shows a histogram of real data from a billing process. A control chart of days (number of days customers take to pay their bills) for nonprepaid invoices showed that the histogram indicates that some customers like to prepay, thus eliminating the work of backing accounts payable. Customers who don't prepay tend to send payments that are late. There is a second, smaller spike after statements are sent, then a gradual drop. It is unbounded because a few of the customers will never pay their bills. This pattern is a good example of human behavior. It is not a normal distribution. It is a mixture of many different processes. It is not a normal distribution. It is a mixture of many different processes. It is not a normal distribution. It is a mixture of many different processes.

Contribution of Time to Pay Invoice

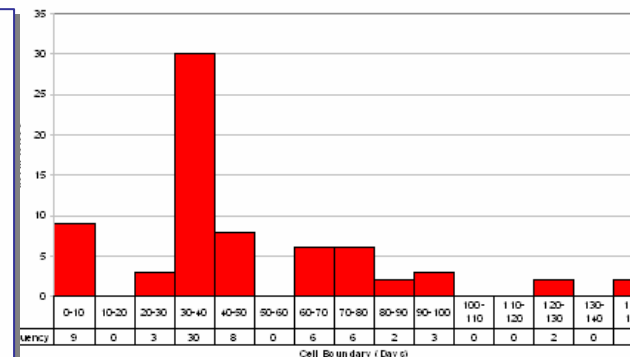


Figure 1: Days between mailing of invoice and receipt of payment.

always follow the "normal law" either. Natural phenomena often pattern. The hot-dip galvanizing process discussed previously is

Inter-active computer worksheets; trainees do some analysis then interpret the output.

# Measures of Success

- **Transfer of Learning**
- **Behavioural Change**
  - Individual
  - Organisational
- **Demonstrable Benefits – Outcomes**
- **Pathway Forward**

# Accountability & Assessment

- **Participation**
  - *Training Program*
  - *Identified Project*
  - *Mentoring*
- **Knowledge**
  - *Usage*
  - *Understanding*
- **Achievement**
  - *Project*
  - *Behaviour*

# Certificate of Participation

- **Requirements:**
  - *attendance at 75% of the training sessions;*
  - *satisfactory completion of 80% of the practical worksheets involving computer analysis of specific data sets;*
  - *active involvement in at least one of the projects designed to accompany the training program;*
  - *participation in the preparation and presentation of project reports at various stages throughout the life of the project.*

# Certificate of Competency

- Only undertaken by request, and took the form of a 45 minute, one-on-one “interview” with the trainer; in effect an oral examination.
  - *– speak to a topic of their choosing as well as one selected by the interviewer;*
  - *– answer various questions about any of the topics covered;*
  - *– interpret computer output in the context of the workplace;*
  - *– use Minitab to perform various analytical tasks given some workplace data.*
- Each participant was provided with a copy of the expected question types before hand.

# Questions . . .

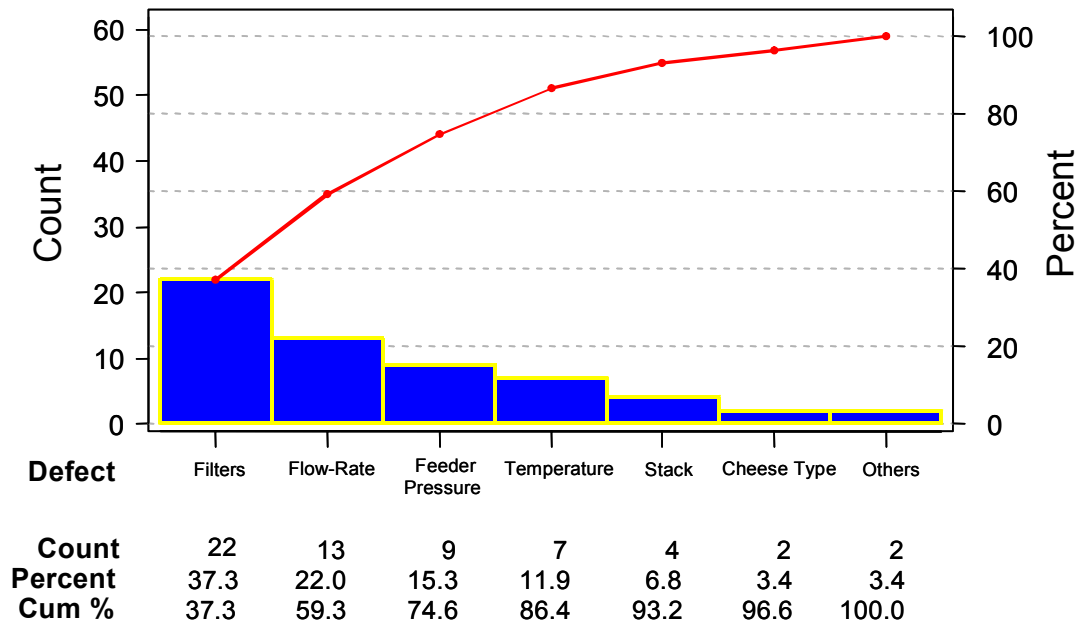
- **Select one of the topics covered and explain what you know about it.**
- **Questions selected according to participant level**
- **Satisfactory response to at least 1 question from each of the topics covered.**

- *What is the purpose of . . .*
- *Describe how you would do . . .*
- *Outline a situation where it might be appropriate to do . . .*

- **EDA**
- **GR&R**
- **Capab Study**
- **Histogram**
- **Pareto Chart**
- **Time Series Plot**

# Interpreting Output

- Here is some Minitab output from an analysis of data collected from your workplace.
  - *What statistical tool is this an example of?*
  - *What does it tell you?*
  - *When might you use a tool such as this?*



# Capability With Minitab

- Here is some data from your workplace.  
Use MINITAB to obtain (& explain)
  - *descriptive stats*
  - *boxplots*
  - *histogram*
  - *normality test*
  - *scatterplot*
  - *etc.*

↓	C1-D	C2	C3	C4	C5	C6
	Sample Date	Effl. Volume	IAF Effl. BOD	IAF Effl. SS	IAF Effl. BOD Load	IAF Effl. SS Load_1
1	1/07/2002	2450	44	62	108.00	152.00
2	2/07/2002	2162	50	119	108.00	257.00
3	3/07/2002	2434	23	56	56.00	136.00
4	4/07/2002	2087	50	91	104.00	190.00
5	5/07/2002	2457	42	66	103.00	162.00
6	6/07/2002	2035	*	*	*	*
7	7/07/2002	2313	*	*	*	*
8	8/07/2002	2284	27	85	62.00	194.00
9	9/07/2002	2313	46	80	106.00	185.00
10	10/07/2002	2018	84	101	170.00	204.00
11	11/07/2002	2921	55	84	161.00	245.00
12	12/07/2002	2179	56	74	122.00	161.00
13	13/07/2002	2288	*	*	*	*
14	14/07/2002	2318	*	*	*	*
15	15/07/2002	2306	47	72	108.00	166.00
16	16/07/2002	2991	48	66	144.00	197.00

# More Questions . . .

- Give me an example that shows the difference between categorical data and continuous data.
- Give me an example of when it might be appropriate to do a time series analysis

- *When would you do a . . .*
- *What are you looking for when you do a . . . .*
- *What do you need to be careful of when you do a . . .*

- Paired t-test
- ANOVA
- Chi-Square Test
- Correlation or Regression
- DOE

# Assessment Results

- Assessment Details:**

\* - needed help; \*\* - good working knowledge; \*\*\* - strong understanding

Group A

Group B

General Topic	Comments	Group A	
		PK	AM
Process Characterisation	<i>What part of the process are you most familiar?</i>	***	***
	<i>What are the KPIV's &amp; how are they measured?</i>	***	***
	<i>What are KPOV's &amp; how are they measured?</i>		
Exploratory Data Analysis	<i>Where is categorical data used?</i>	***	**
	<i>Where is continuous data used?</i>	***	***
	<i>What does the stdev measure?</i>	***	**
	<i>What does the mean measure?</i>		
	<i>How do we know if the data is normal?</i>		
	<i>Why do we want to know if the data is normal?</i>		
Familiar Topic		EDA Cap	Cap Regr

Group B	
SP	CM
***	**
	**
***	***
**	**
ANOVA Cap	Nested GR&R

# Assessment Results

- Minitab Tasks:**

**\*\* - needed some help; \*\*\* - unassisted**

	Tasks	Group A		Group B	
		PK	AM	SP	CM
	Descriptive Stats (Fill by Machine)	***	***	***	**
	Histogram (with normality test)	***	***		**
	Boxplots of Moisture by Pallet				
	Scatterplot of SubA by SubB				
	Pareto (Stoppages)	***	**	***	***
	1-Way ANOVA (Fill by Machine)	***	***	**	**
	2-Way ANOVA (Fill by Mach & Head)	***	**		

# My Evaluation

- **Trainer Comments:**
  - *Ex u/standing & appreciation of need & usefulness of tool*
  - *Strong u/standing & appreciation of tools; realises power of applying tools; awkward expression at times.*
  - *V.good u/standing & appreciation of tools; quiet confidence in use; good role model/mentor potential.*
  - *Ltd u/standing; basic working knowledge; doesn't appreciate or u/stand need for tools*
  - *Very strong knowledge in many areas; keen to apply; excellent attitude; sees value & potential*

# Their Evaluation

- **Trainee Comments:**
  - *Great value personally, but needs project running alongside; Prefer individual carry their own project rather than group effort*
  - *Appropriate content, ex reference when reviewing post trng.*
  - *A/B break-up v.good & good timetabling (1/2 day sessions)*
  - *Waste of time and money*
  - *Can see the value, but felt a bit left behind; need slower pace;*
  - *More exercises/homework with fully worked answers*
  - *Value for \$; gets to the nuts & bolts and enables you to see diff's b/w issues that do & don't count.*

# Changes in Behaviour

- **Project Scoping**
- **Communication – Reporting back**
- **Flow-On Effect – to other issues/projects**
- **Further Training (or re-training . . . )**
- **In-House Mentoring/Training**