June 20, 2011 (Monday) Pre-Congress Seminars

KEMPINSKI HOTEL CORVINUS **Erzsébet tér 7-8, Budapest V.**

SALON BANDINI

5.1-2. Pre-Congress Workshop 2a — Monday 10:00 – 13:00

10.00 Statistical Thinking Development for a Proactive Quality Assurance
Miflora M. Gatchalian and May Lynn G. Miranda, Quality Partners Company, Ltd., Philippines

Gatchalian, Miflora M. (Philippines), Member of the International Academy for Quality (IAQ)

She earned Doctorate's degree from the University of Tokyo in Japan, Master of Arts in Statistics and BS Food Technology degrees from the University of the Philippines (U.P.). Her graduate Diploma in Industrial Quality Control was obtained with distinction in Holland. Her certification as "HACCP and SCP (Sanitation Control Procedures) Trainer" was obtained from the Association of Food and Drug Officials Sea Food Alliance, FDA, United States.

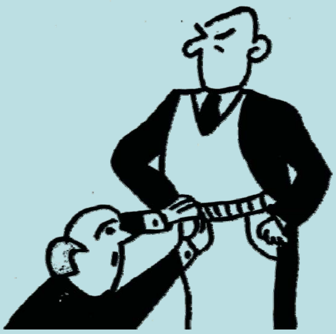
She is a member of the prestigious International Academy for Quality and is the Philippine Counselor and Fellow of the American Society for Quality (ASQ). She is the Secretary General, *Emeritus* of the Asia Pacific Quality Organization and had been past President of both the Federation of Institutes of Food Science and Technology in ASEAN and the Philippine Society for Quality. She is the Founding President of the Philippine Association of Food Technologists. She received several major honours and awards. She has written and published a lot of books on Sensory Evaluation, quality and statistics, research articles in internationally peer-reviewed Journals. The 3rd edition of "Sensory Quality Measurement: Statistical Analysis of Human Responses" was launched in March, 2009.

STATISTICAL THINKING DEVELOPMENT FOR A PROACTIVE QUALITY ASSURANCE

55th EOQ CONGRESS, BUDAPEST, HUNGARY
PRE-CONFERENCE HALF-DAY SEMINAR-WORKSHOP
JUNE 21, 2011

RESOURCE PERSONS:
DR. MIFLORA M. GATCHALIAN
CEO, QUALITY PARTNERS COMPANY, Ltd
And
MAY LYNN G. MIRANDA
ASSOCIATE, QUALITY PARTNERS CO. LTD

CONCEPT OF MEASUREMENT



" If you can measure that of which you speak, and can express it by a number, you know something of your subject…..

…but if you cannot measure it, your knowledge is meager and unsatisfactory."

TWO MAJOR PRE-REQUISITES TOWARDS TOTAL QUALITY MANAGEMENT

(Continual Improvement in a Proactive Quality Assurance Scenario)

- ❖QUALITY MINDEDNESS ENHANCEMENT (MAKING QUALITY A WAY OF LIFE)
- ❖STATISTICAL THINKING DEVELOPMENT (MEASUREMENT, ANALYSIS AND REVIEW)

PHIPIPPINE QUALITY AWARD PATTERNED AFTER THE MBNQA CRITERIA

TO DETERMINE THE COMPANY'S LEVEL OF TQM PRACTICE

4. Measurement, Analysis, Knowledge Management

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The full benefits of statistical methods to improve quality, increase productivity, and reduce cost is realized when you focus your efforts on the processes which generate the output.

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5 - Modules in "Statistical Thinking Development" (STD)

MODULE 1 - BASIC STATISTICAL METHODS
A review of basic concepts and applications necessary to fully appreciate and use properly the succeeding modules

MODULE 2- STATISTICAL PROCESS CONTROL
3 approaches to monitor variations in process outputs and 4 to determine process performance with capability measurement .

MODULE 3 – ACCEPTANCE SAMPLING PLANS
Methods of sampling, understanding the O.C curve relative to defect occurrence , proper selection and use of Mil Stds or ISO 2859

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5 - Modules in "Statistical Thinking Development" (STD)

MODULE 4 – BASIC PROBLEM-SOLVING TECHNIQUES

More than ten different tools intended for immediate application by employees in the quest for continual improvement

MODULE 5- DESIGN OF EXPERIMENTS (DOE) (CLASSICAL METHOD)

Very useful approaches for product or process development or improvement in different types of situations starting with bi-variate to multi-variate. Allows for measurement of single effects and interactions between two or more variables.

STATISTICAL THINKING DEVELOPMENT (STD)

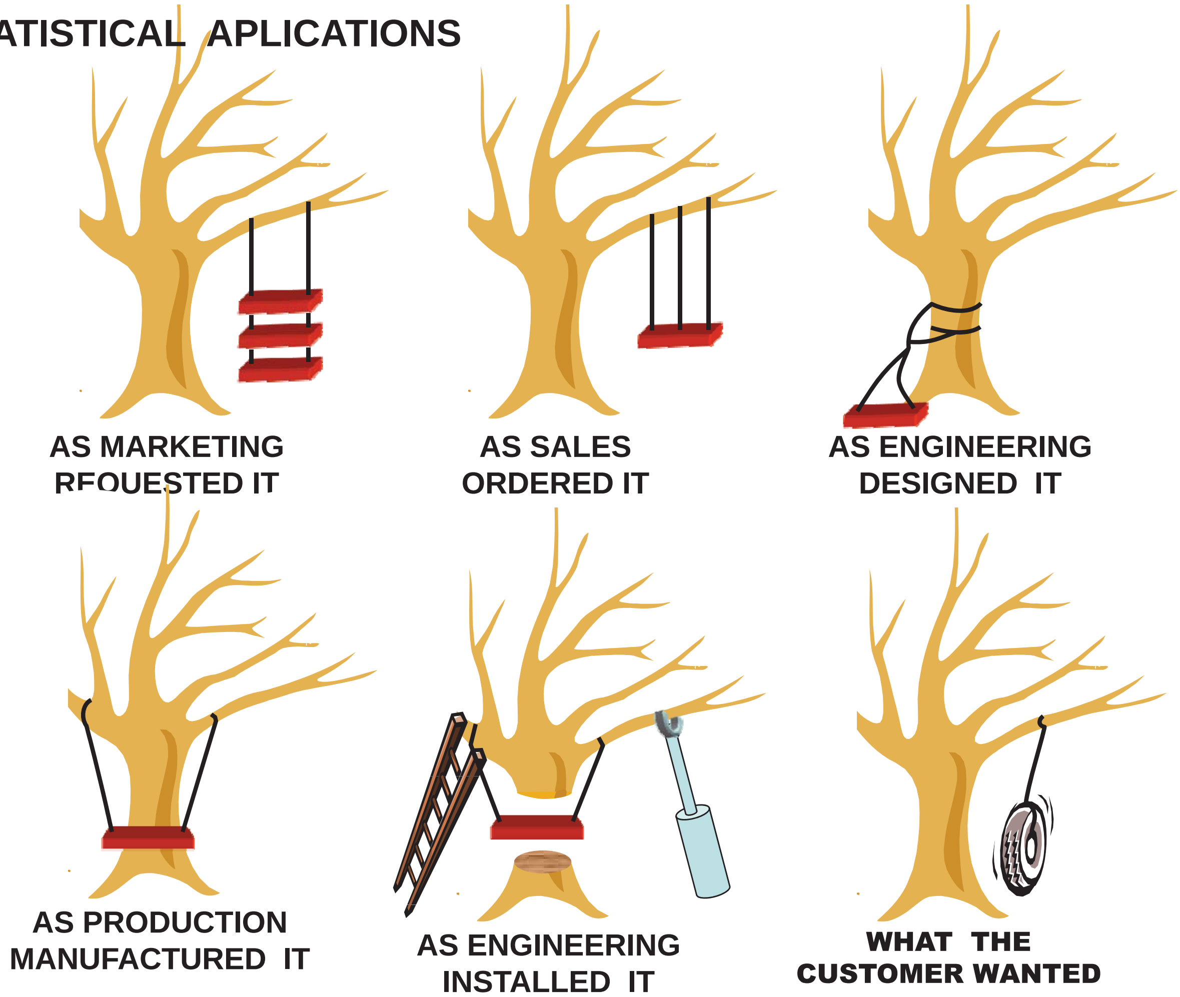
- **MODULE 1- BASIC STATISTICAL TECHNIQUES**

  - STATISTICAL CONCEPTS: SAMPLING, SAMPLE , POPULATION, PROBABILITY
  - MEASURES OF CENTRAL TENDENCY: MEAN, MEDIAN, MODE
  - MEASURES OF VARIATION: RANGE, STANDARD DEVIATION

WORKSHOPS ON BASIC STATISTICAL METHODS AT PHILIPS

SPECIFICATION SETTING

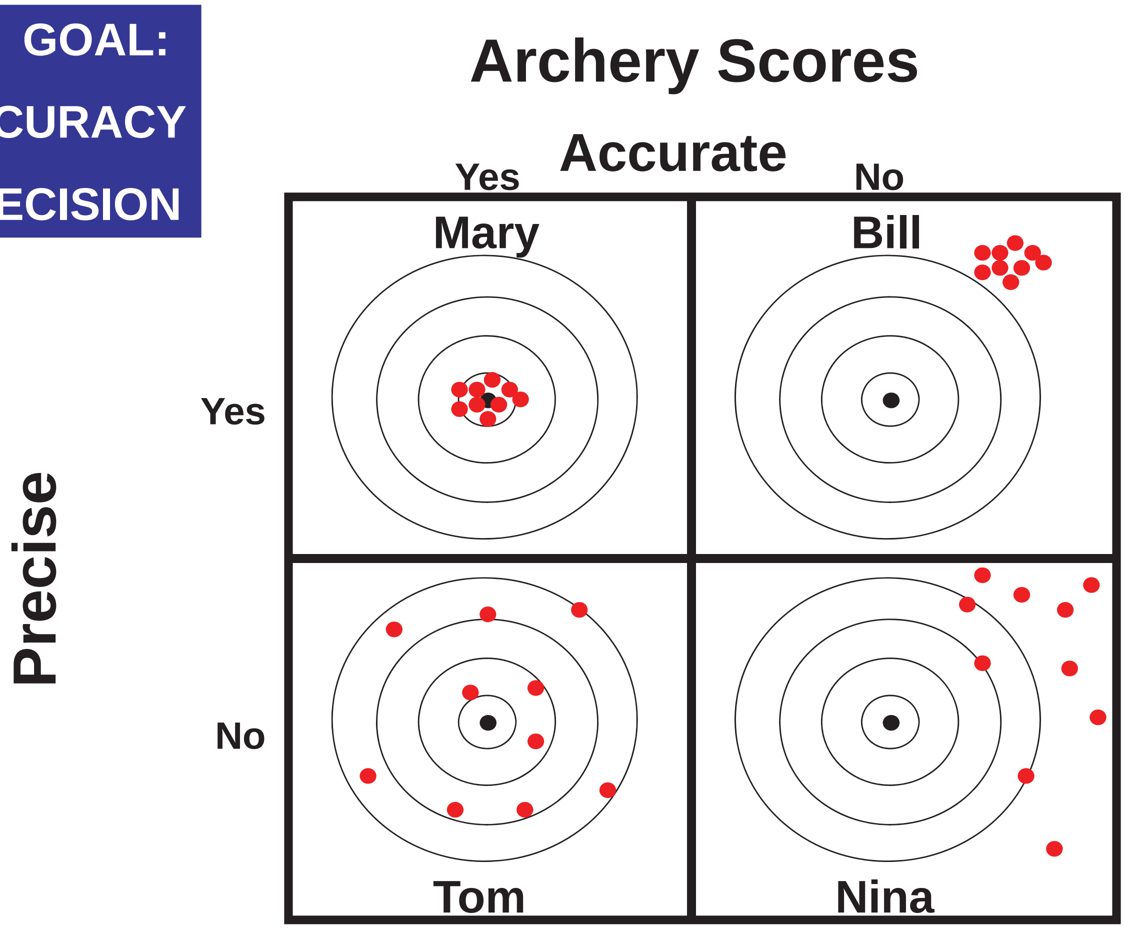
STATISTICAL APLICATIONS



STD GOAL:

✓ACCURACY

✓PRECISION



Sample raw data: Thickness (mm.) of board

3.7	3.5	3.7	3.9	3.9
3.7	3.5	3.6	4.1	4.1
3.6	3.3	3.5	3.3	3.7
3.6	3.2	3.4	3.3	3.7
3.7	3.9	3.4	3.4	3.5
4.0	3.6	3.9	3.5	3.3
4.0	3.7	3.9	3.6	3.3
3.8	3.9	3.7	3.7	3.4
3.7	4.0	3.7	3.8	3.5
3.9	3.6	3.8	3.9	3.6

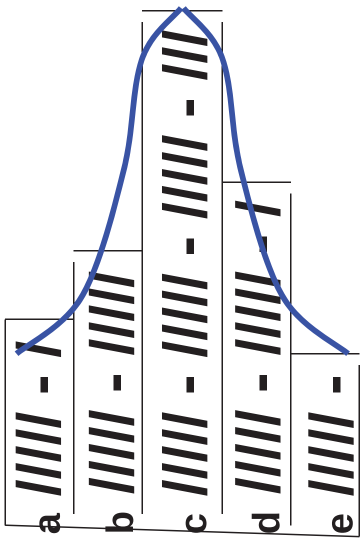
Board thickness arranged in an array.

3.2	3.5	3.6	3.7	3.9
3.3	3.5	3.6	3.7	3.9
3.3	3.5	3.6	3.7	3.9
3.3	3.5	3.7	3.7	3.9
3.3	3.5	3.7	3.8	3.9
3.3	3.5	3.7	3.8	4.0
3.4	3.6	3.7	3.8	4.0
3.4	3.6	3.7	3.9	4.0
3.4	3.6	3.7	3.9	4.1
3.4	3.6	3.7	3.9	4.1

Class groupings for board thickness with corresponding tally values

	Class intervals	Tally values
a)	3.2 - 3.3	///// - /
	3.4 - 3.5	///// - /////
	3.6 - 3.7	///// - ///// - ///// - ///
	3.8 - 3.9	///// - ///// - /
	4.0 - 4.1	///// -

A Histogram from Tally Sheet



1. Letters a to e correspond to class a to e in the tally sheet
2. Height of each rectangle correspond to the number in the tally
3. When mid-points of each rectangle are connected, the shape of the curve will look like a cone
4. A symmetrical curve is known as a normal distribution
5. Highest point contains the value of the mean

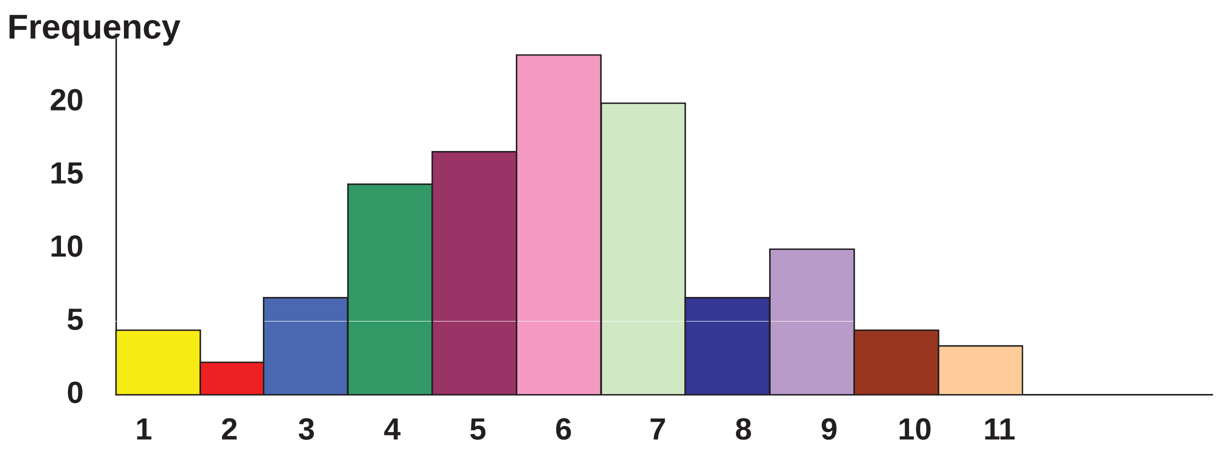


Fig. 1. Typical Frequency Histogram

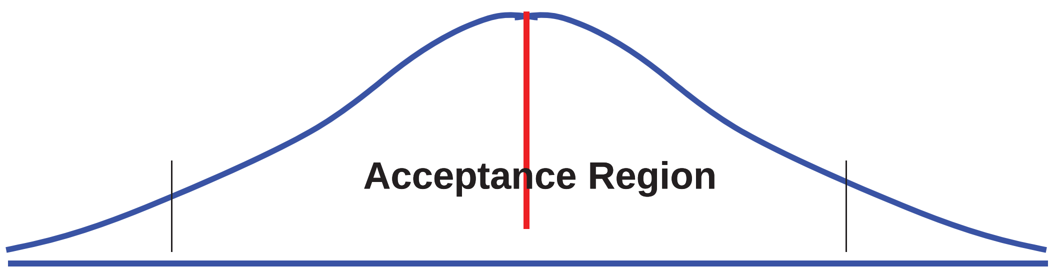


Fig. 2. Normal distribution showing acceptance and rejection regions

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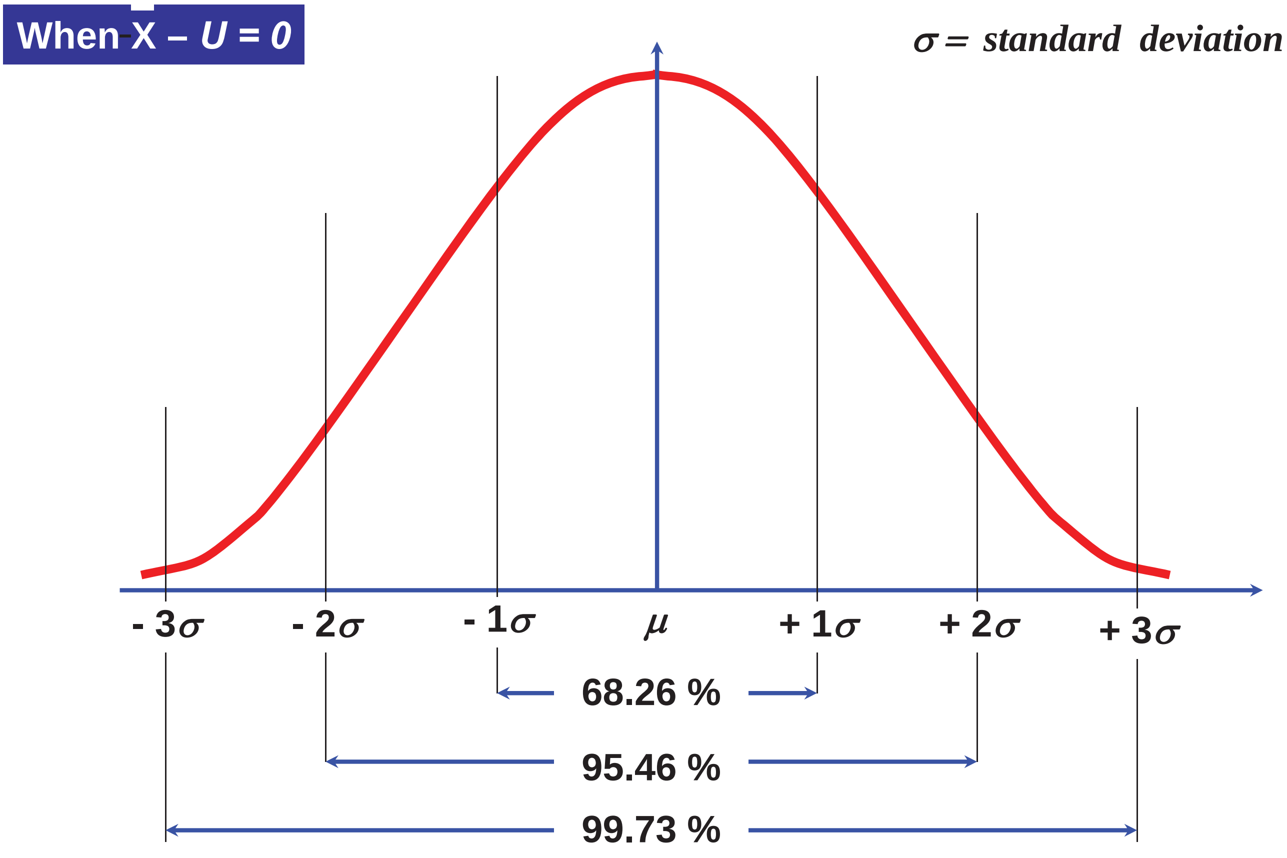
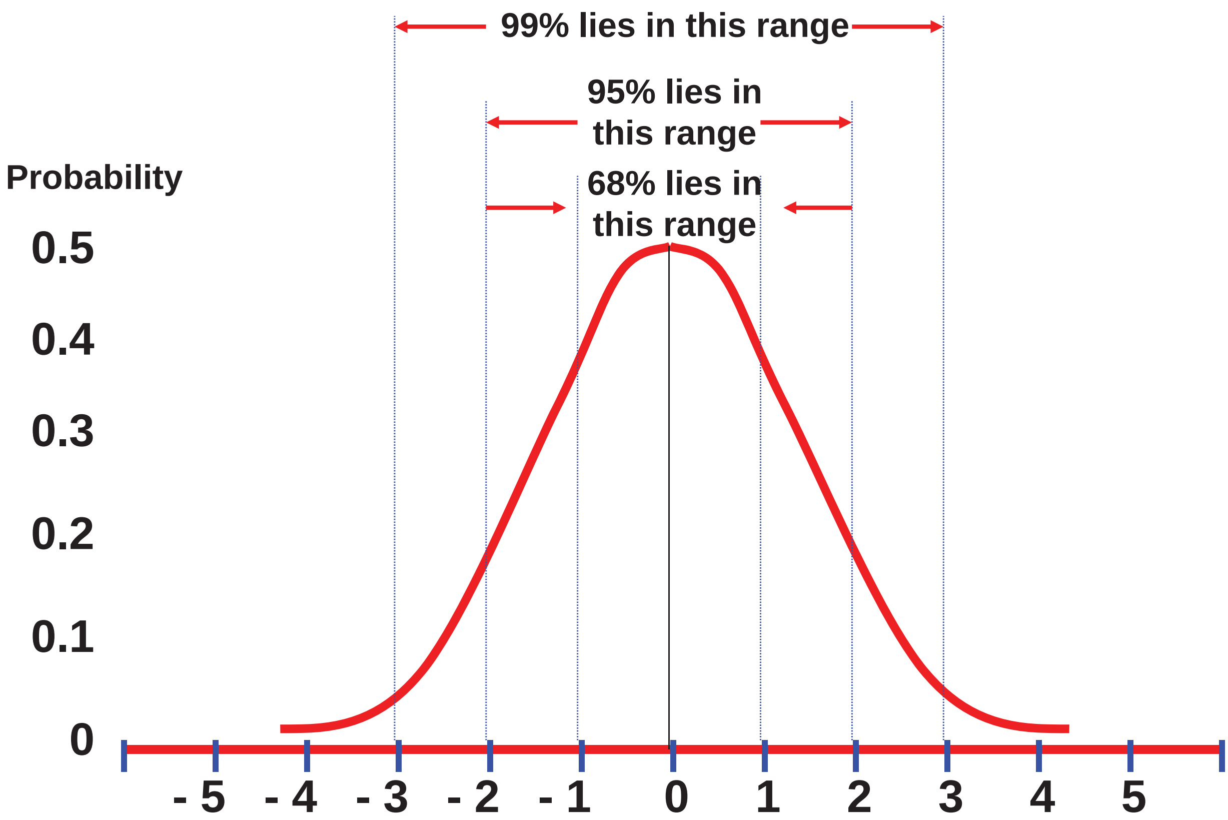


Areas of a normal curve



PROPORTIONS UNDER NORMAL CURVE FOR Z=1,2,3

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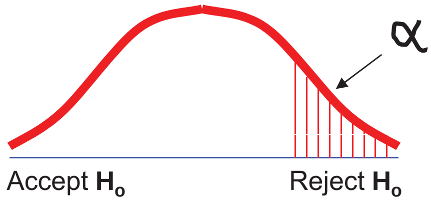
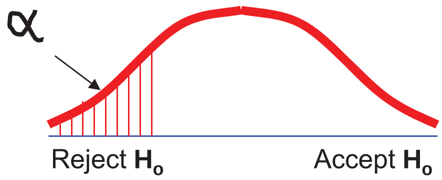
	TRUE	TRUE
	H_o	H_A
Accept H_o	CORRECT DECISION 95, 99%	INCORRECT DECISION 0, 1, 5%
Reject H_o	INCORRECT DECISION 5, 1%	CORRECT DECISION 99, 95%

BASIS FOR TESTING HYPO-THESIS

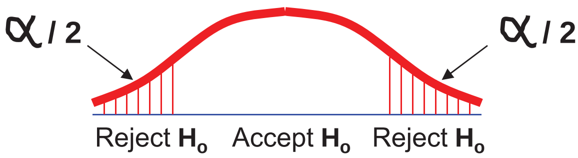
$H_o: \mu_1 = \mu_o$
$H_A: \mu_1 > \mu_o$
at level α



$H_o: \mu_1 = \mu_o$
$H_A: \mu_1 < \mu_o$
at level α



$H_o: \mu_1 = \mu_o$
$H_A: \mu_1 \neq \mu_o$
at level $\alpha / 2$



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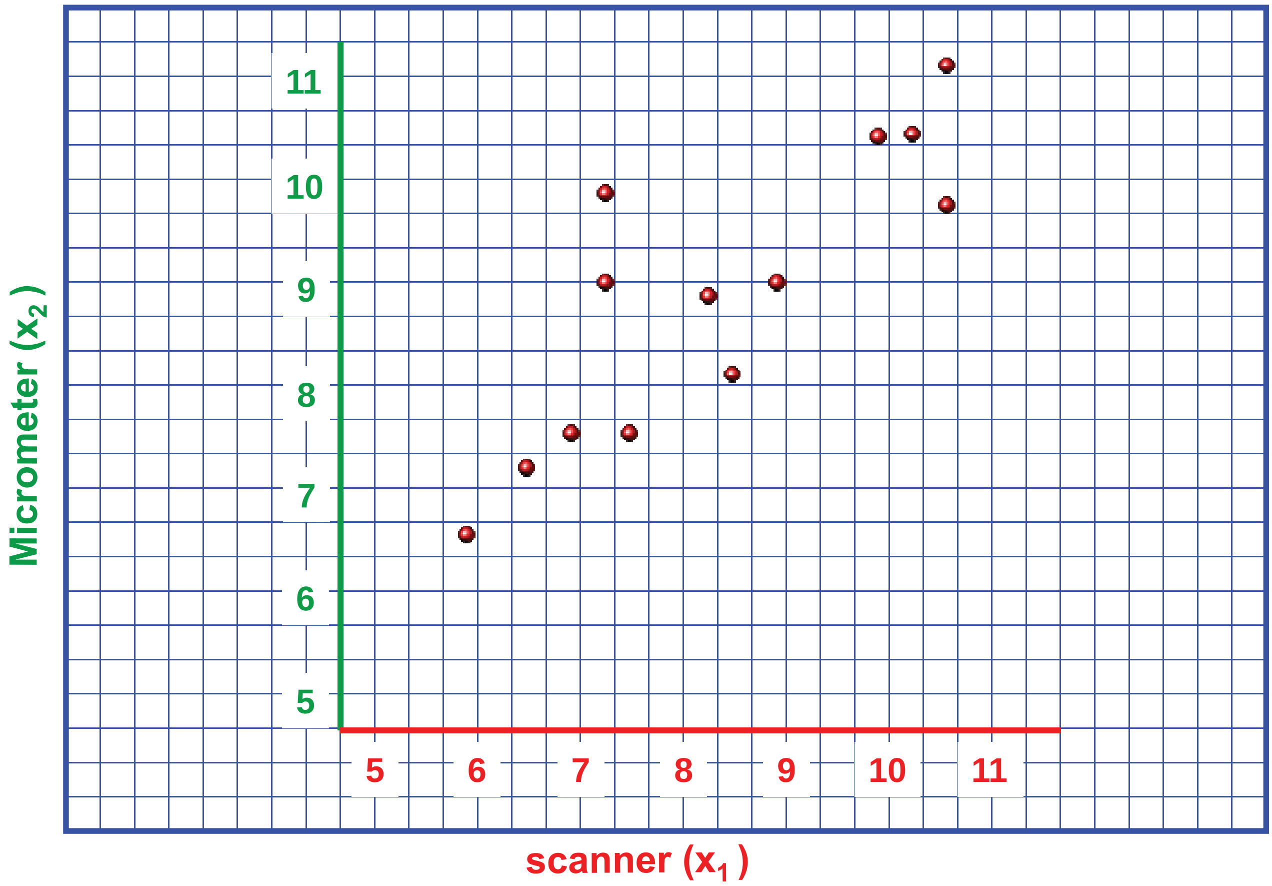
Comparison of scanner and micrometer



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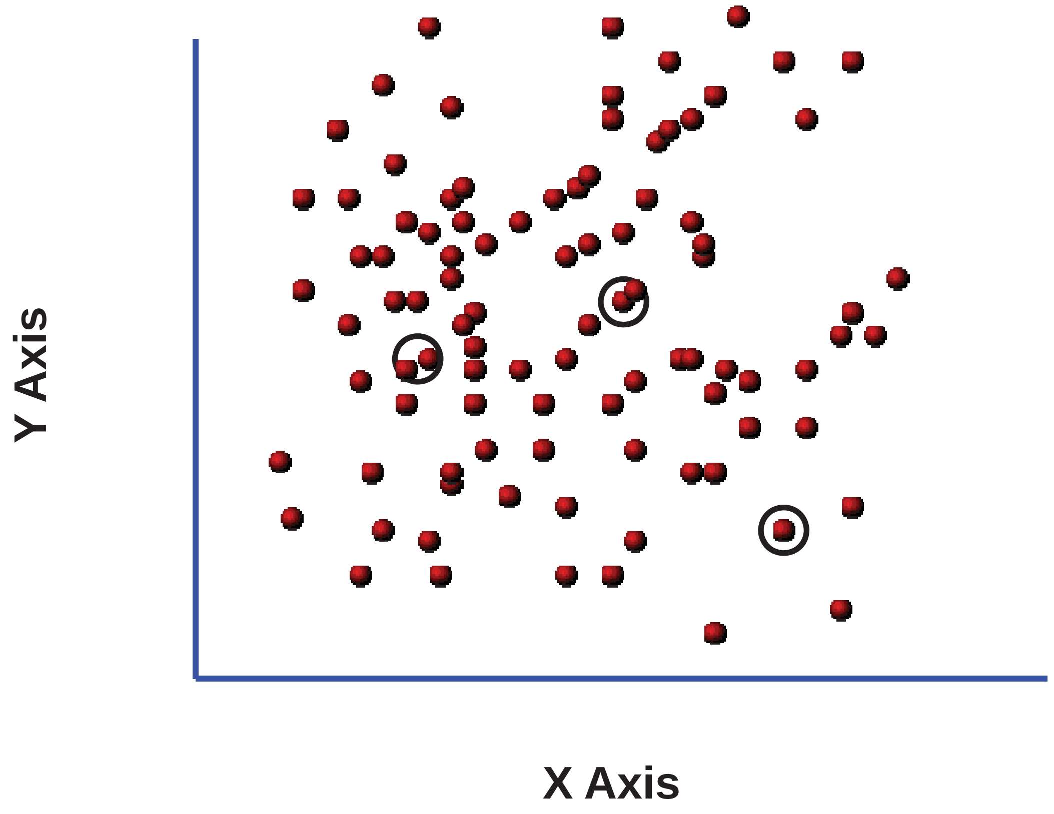
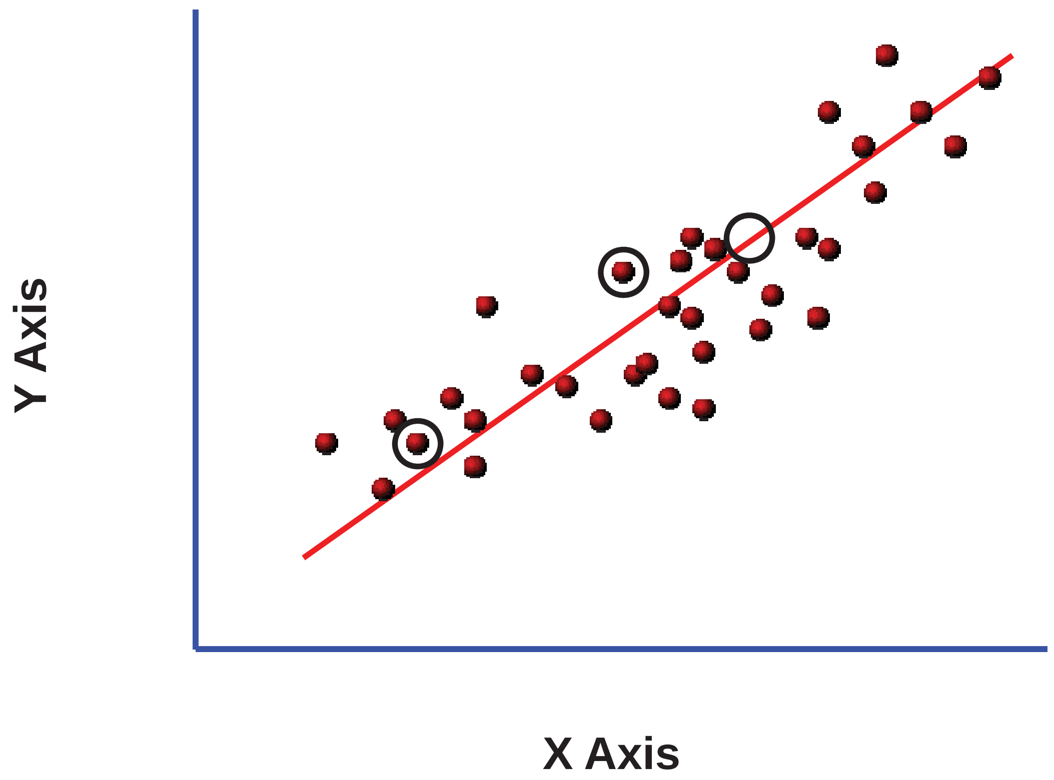
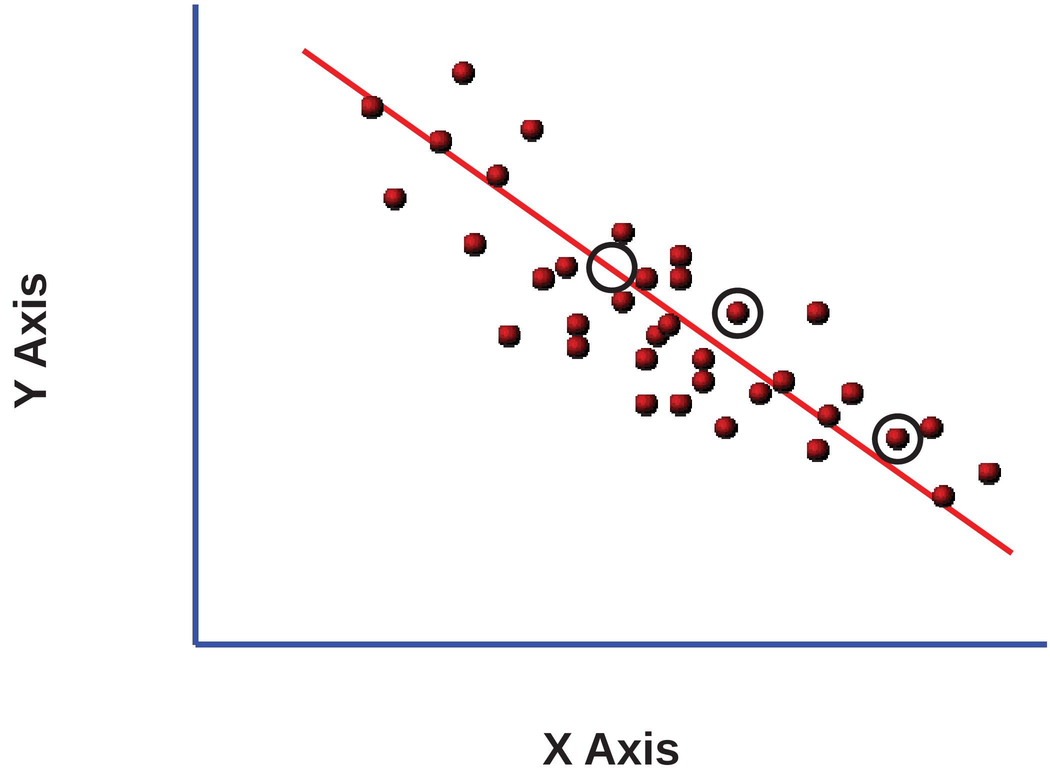
1. No Correlation



2. Positive Correlation



3. Negative Correlation

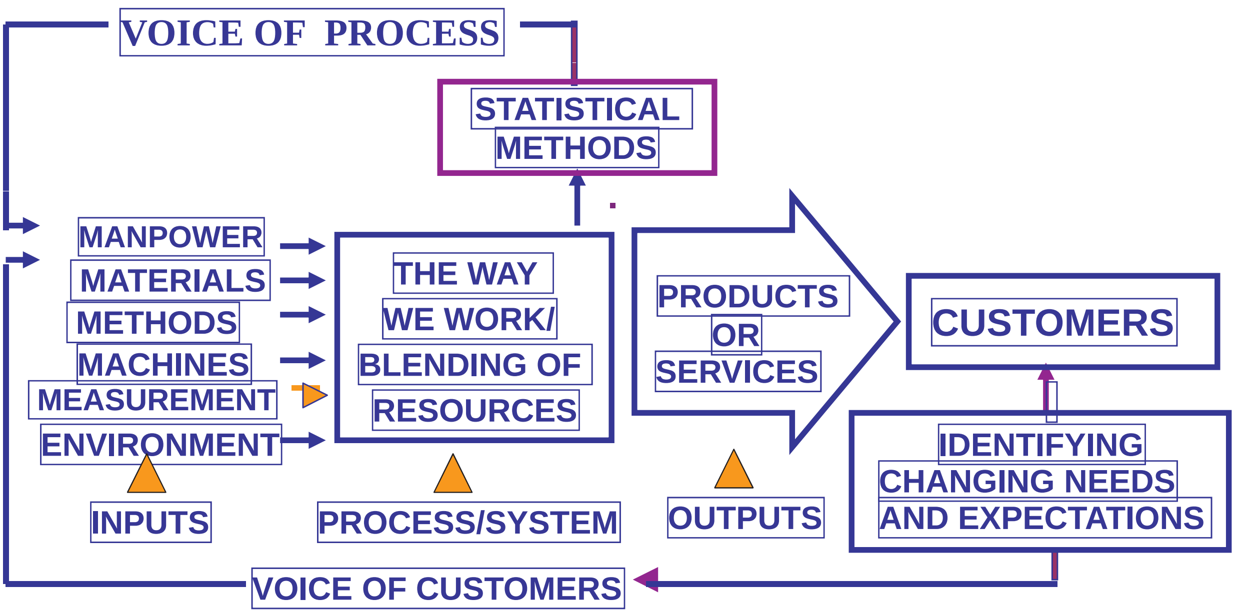


MODULE 2
STATISTICAL PROCESS CONTROL (SPC)

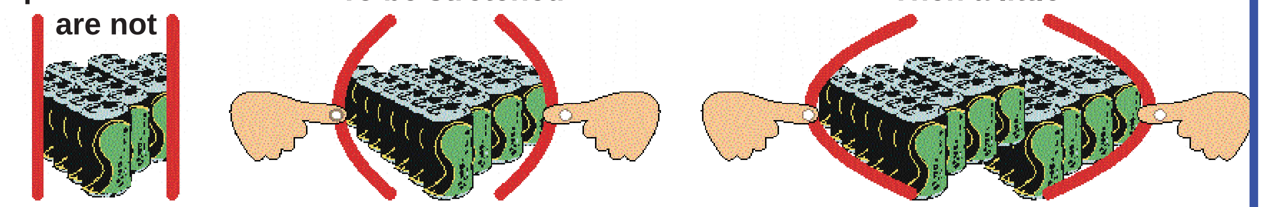
Is the application of statistical principles using relatively easy to use but powerful tools for the control of PROCESSES.

WHAT IS A PROCESS ?

A process is a WORK ACTIVITY that CHANGES or BLENDS IN PUTS (often ADDS VALUE) to produce PRODUCTS or SERVICES



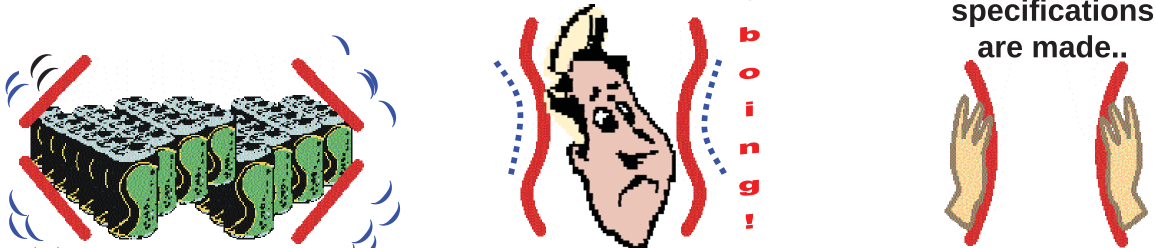
Specifications are not — To be stretched — Then a little



Rubber bands — When necessary — W – I – D – E - R

ONE OF THE REASONS FOR REQUESTS FOR TIGHTER SPECIFICATION IS VIOLATION OF THOSE…… WE HAVE .

Until some real clinkers — And the whole thing — And specifications are made..



Get through — Snaps back in your face. — Tighter than ever

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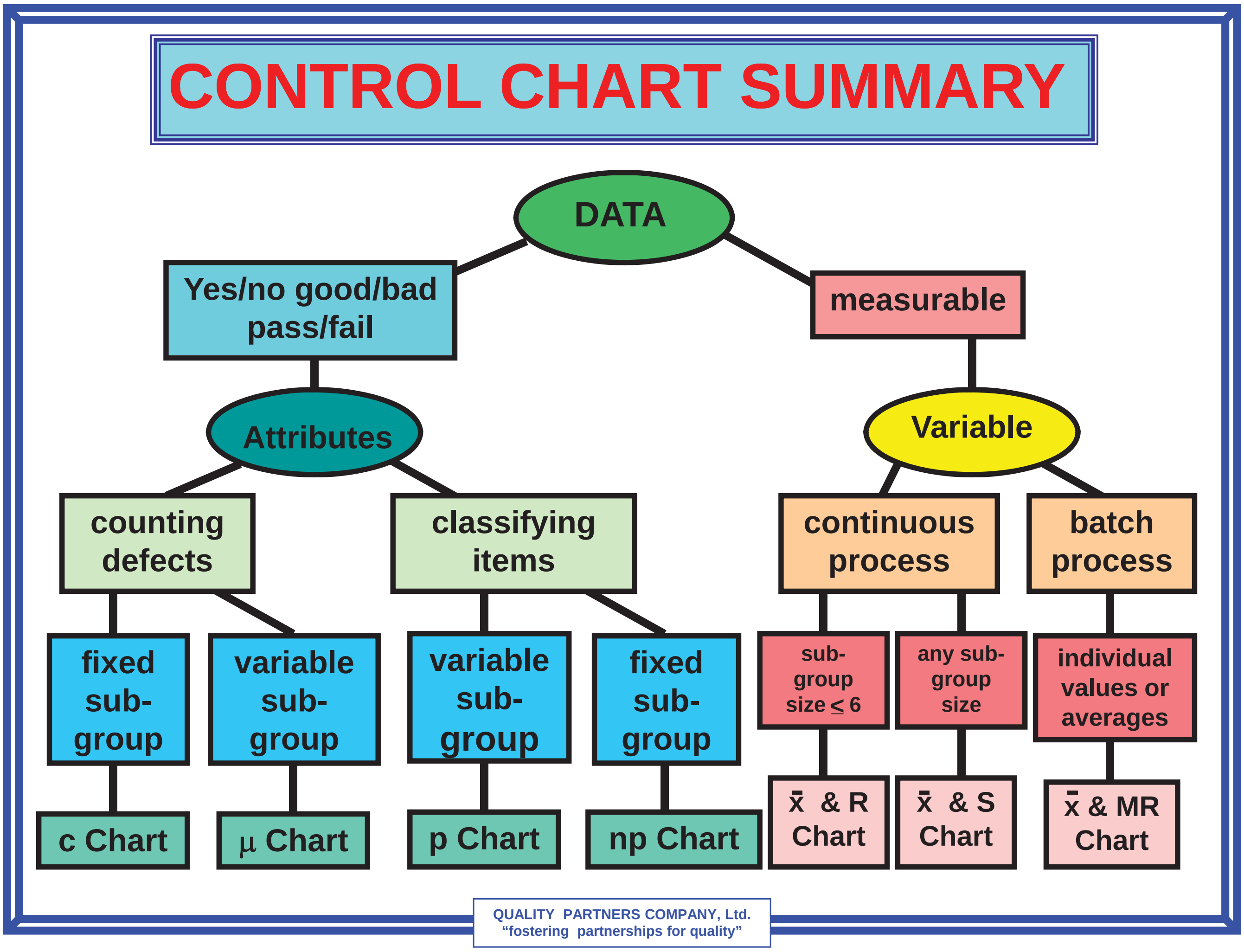
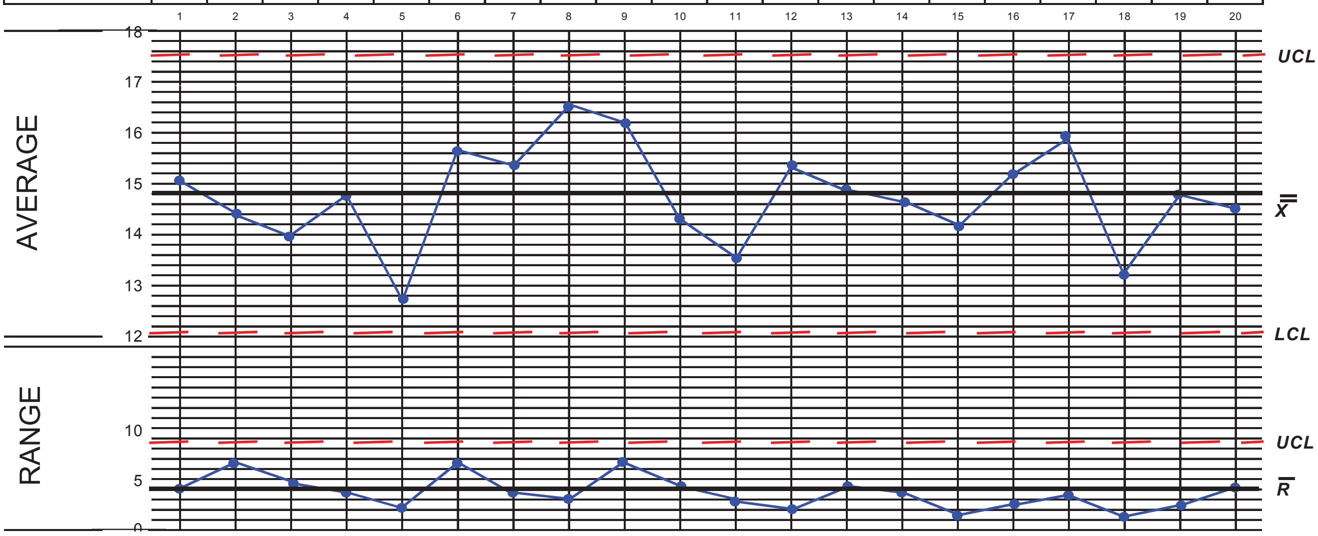
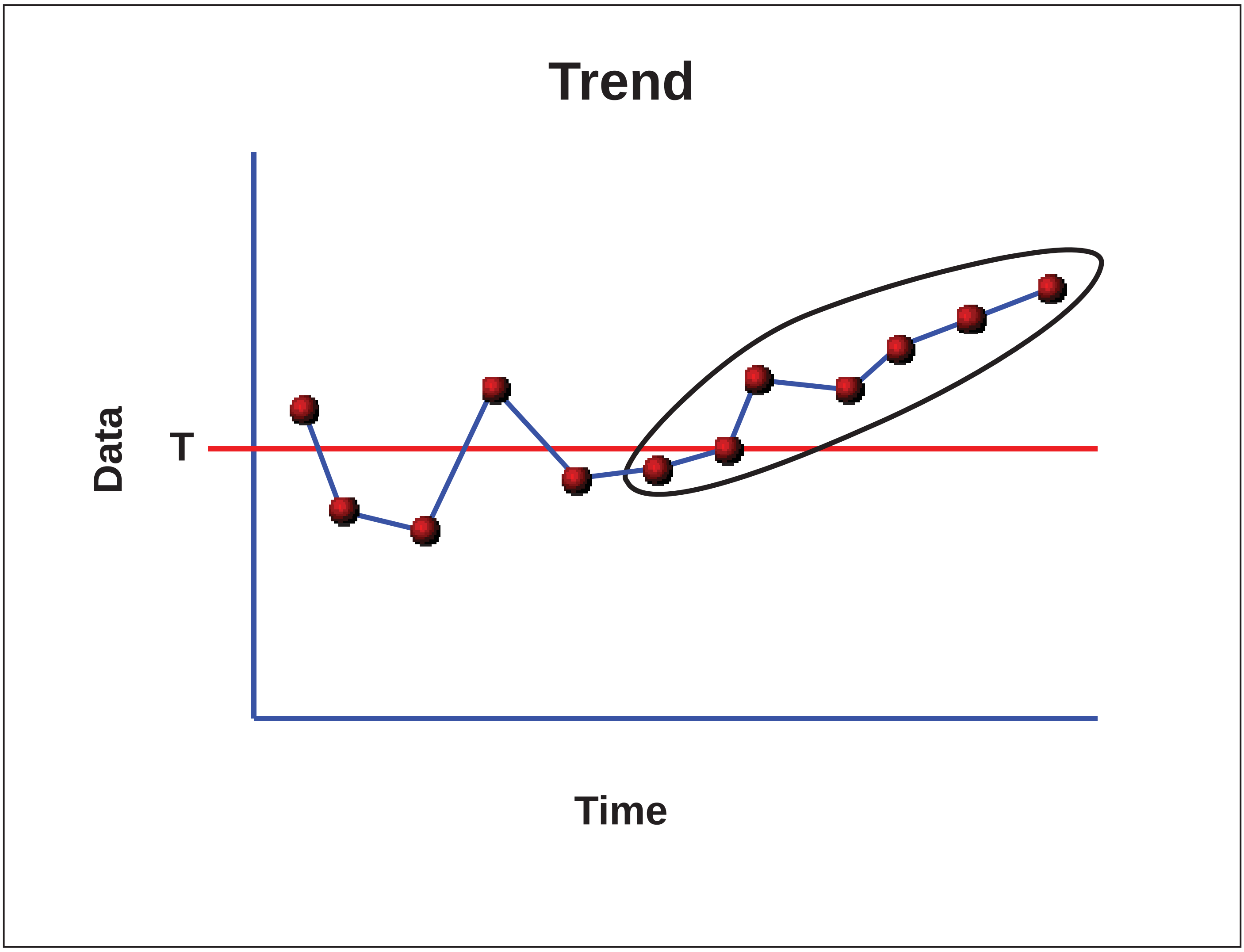


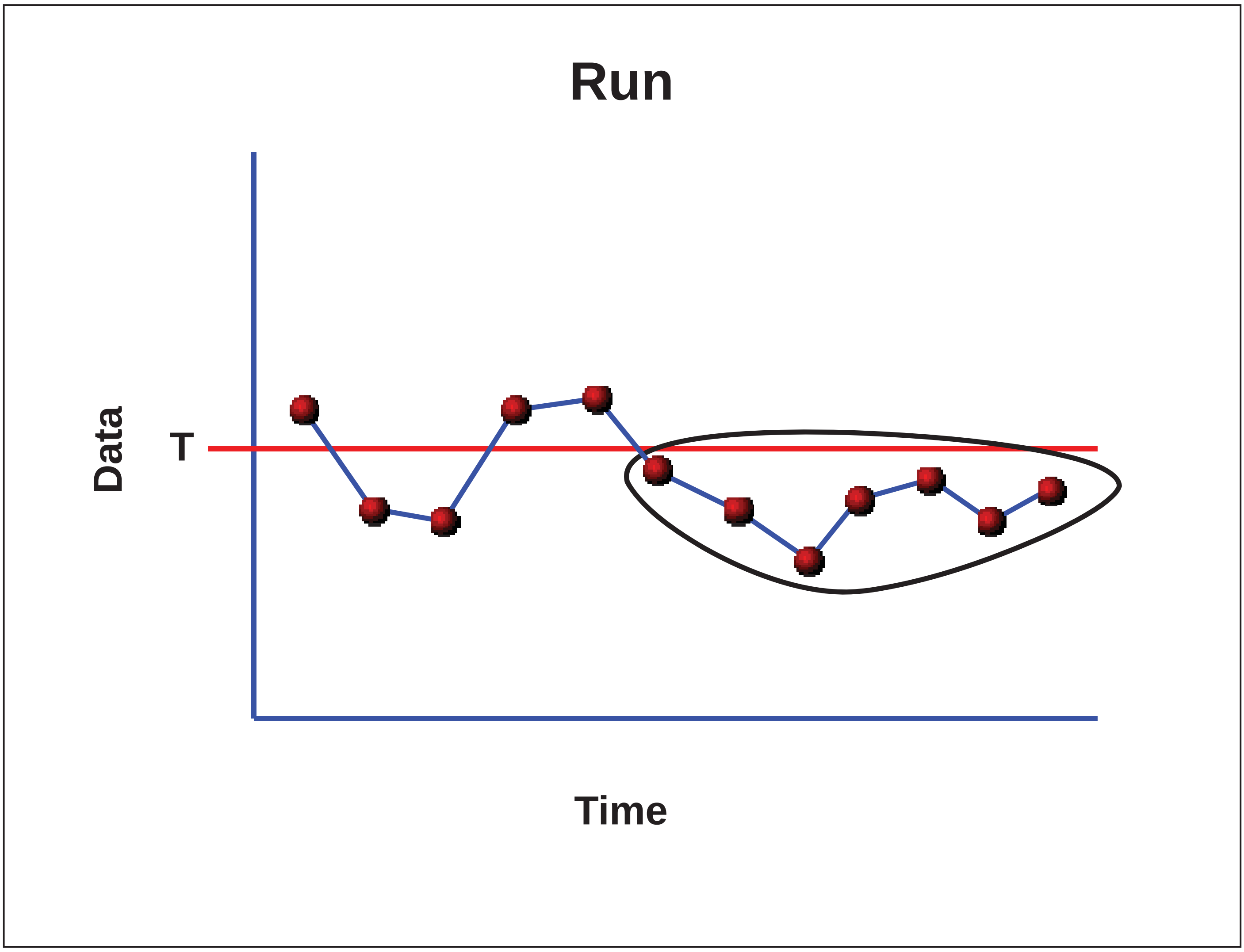
VARIABLES CONTROL CHART ($\bar{X}$ & R)

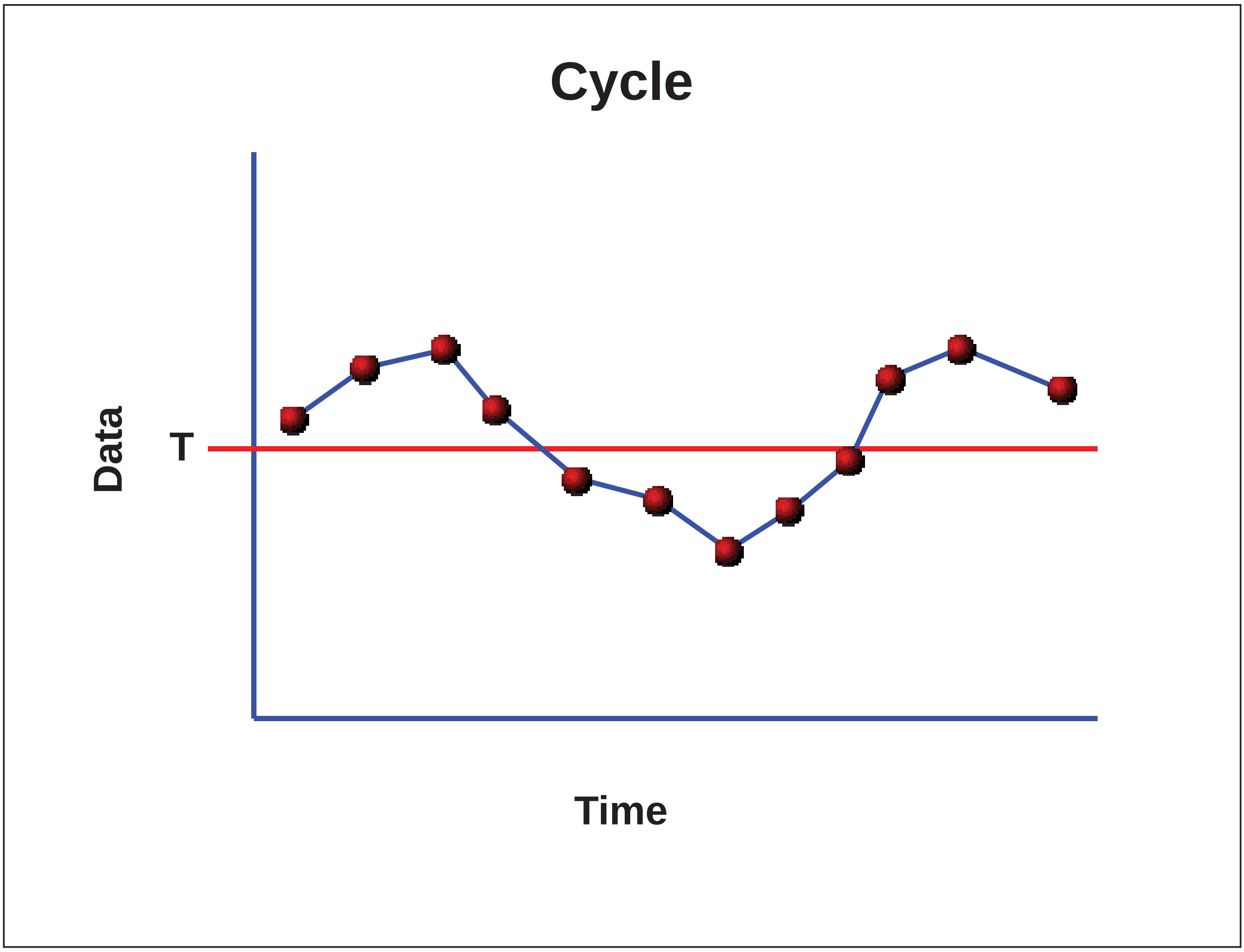
PRODUCT gas	OPERATION *Van gas mileage*	CONTROL LIMITS $\bar{X}$ LCL UCL / RANGE UCL
OPERATORS Juan de la Cruz	MACHINE Car	SPECIFICATION LIMITS
		UNITS OF MEASURE *mpg*

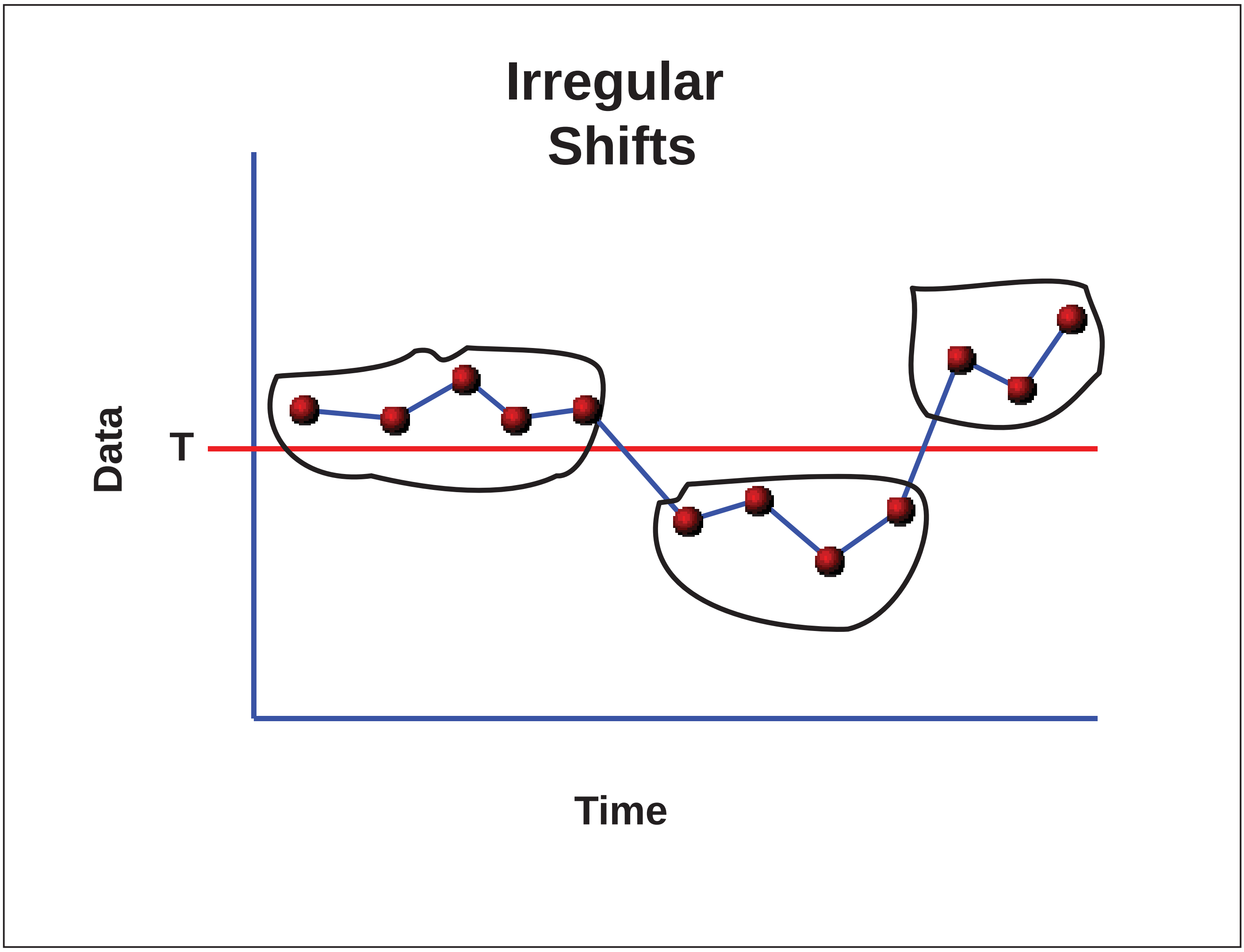
SAMPLE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
DATE																				
SAMPLE MEASUREMENTS 1	14.3	11.0	15.2	15.9	11.2	14.9	14.3	17.0	16.0	16.7	14.4	15.2	15.4	13.9	14.6	13.7	15.6	12.4	14.7	13.2
2	14.8	16.9	16.8	15.9	13.1	19.5	15.7	14.7	16.0	15.7	11.8	16.5	13.1	14.7	13.2	15.6	18.2	13.2	14.1	17.3
3	13.6	17.4	11.9	12.0	13.4	14.7	17.3	17.7	19.8	12.4	14.8	15.0	17.3	16.9	14.8	15.8	14.9	13.7	13.9	14.3
4	17.6	11.8	12.1	15.1	13.0	13.4	13.8	17.4	13.1	12.4	13.3	14.5	13.7	13.2	14.3	16.2	15.0	13.6	16.3	13.4
5																				
6																				
AVERAGE $\bar{X}$	15.1	14.3	14.0	14.7	12.7	15.6	15.3	16.7	16.2	14.3	13.6	15.3	14.9	14.7	14.2	15.3	15.9	13.2	14.8	14.6
RANGES $\bar{R}$	4.0	6.4	4.9	3.9	2.2	6.1	3.5	3.0	6.7	4.3	3.0	2.0	4.2	3.7	1.6	2.5	3.3	1.3	2.4	4.1
NOTES																				

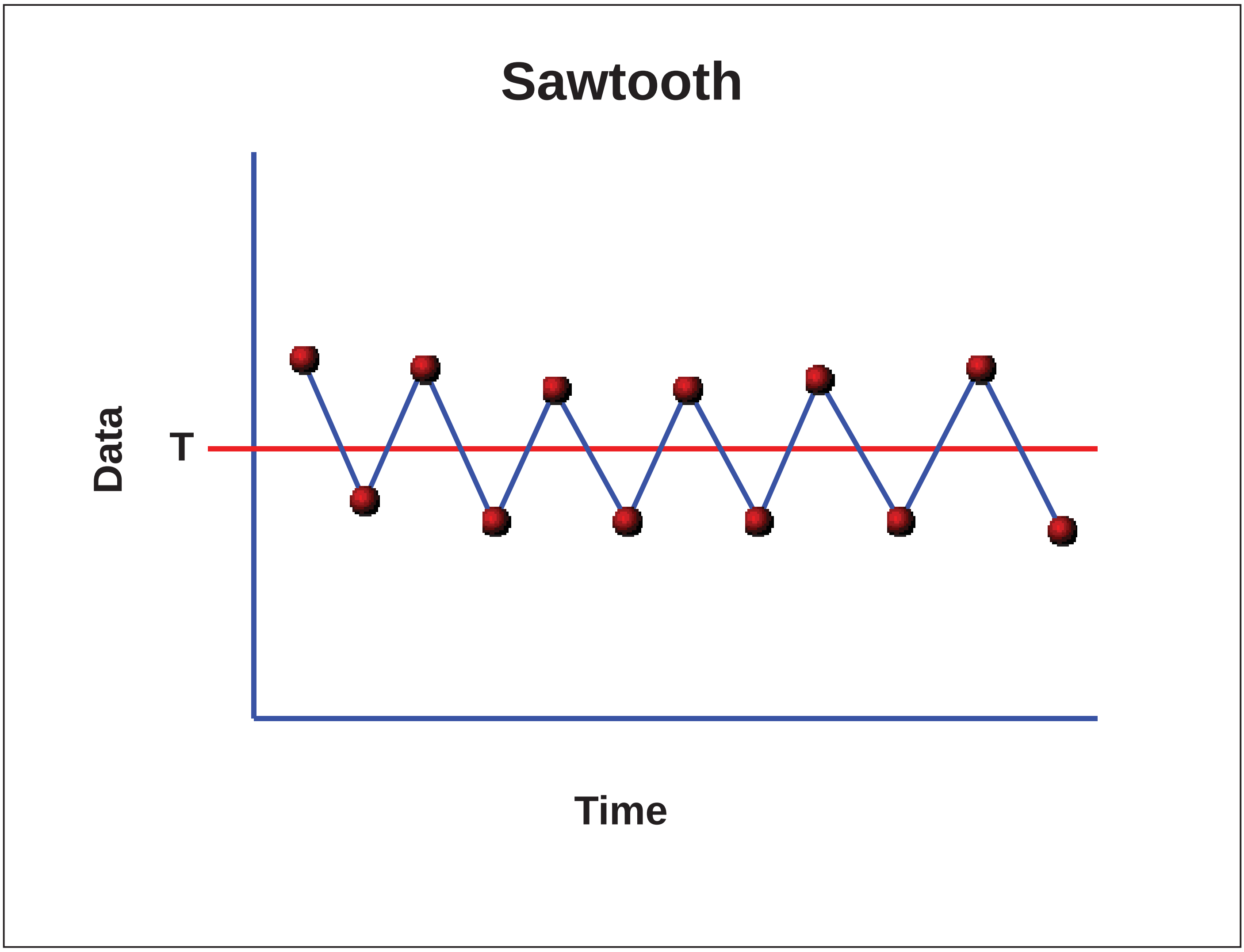


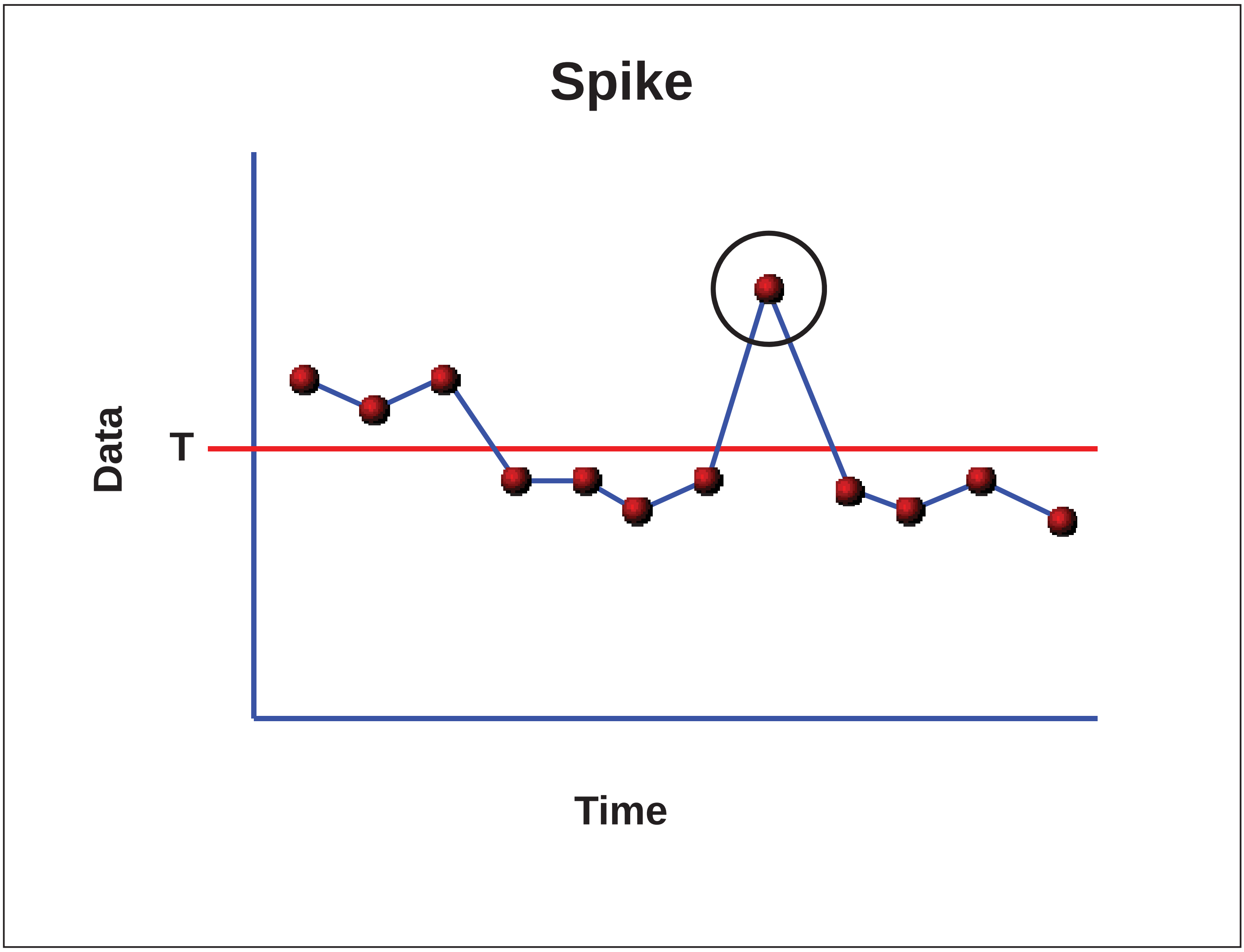

Trend
Data
T
Time


Run
Data
T
Time


Cycle
Data
T
Time


Irregular
Shifts
Data
T
Time


Sawtooth
Data
T
Time


Spike
Data
T
Time

DETERMINING PROCESS CAPABILITY

When the variation in process capability exceeds that in product specifications, companies need to know how much material will not conform to specifications.

Cpl and Cpu INDICES

Cpl and Cpu are used for one-sided requirements.

Cpl is calculated using the Lower Specification Limit (LSL)

$$Cpl = \frac{\bar{\bar{X}} - LSL}{3\hat{\sigma}}$$

Cpu is calculated using the Upper Specification Limit (USL)

$$Cpu = \frac{USL - \bar{\bar{X}}}{3\hat{\sigma}}$$

Examples (cont'd)

THE Cpk INDEX

$$Cpl = \frac{\bar{\bar{X}} - LSL}{3\ s} = \frac{4.43-3.50}{3(.0688)} = 0.45$$

The Cpl accurately indicates that the process is not operating well within the LSL of 3.5 mm.

We can calculate the fraction of shafts that will be out-of-specs by using the following equation:

$$Z_{LSL} = \frac{LSL - \bar{\bar{X}}}{s} = \frac{3.50- 4.43}{0.688} = -1.35$$

From the normal probability table, we see that at z=-1.35 (left tail), the proportion of products with value less than 3.5 mm is .0885 or 8.9% of the shafts will be below the LSL of 3.5 mm.

Examples – Figure A (cont'd)

THE Cpk INDEX

Cpk = min (Cpu, Cpl)

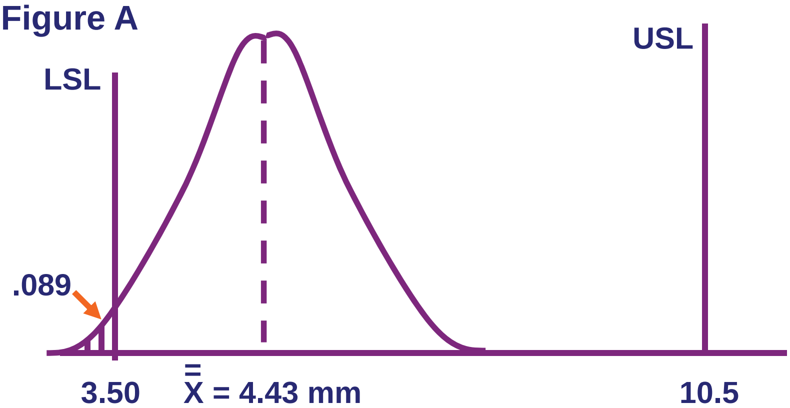
For the example: Cpl = 0.45 Cpu = 2.94

As such, Cpk = 0.45

Therefore, Cpl is minimum.

Cpk indicates a process that will produce a great deal of out-of-specs products. This is reasonable because 8.9% of the products will be out-of-specs.

Figure A

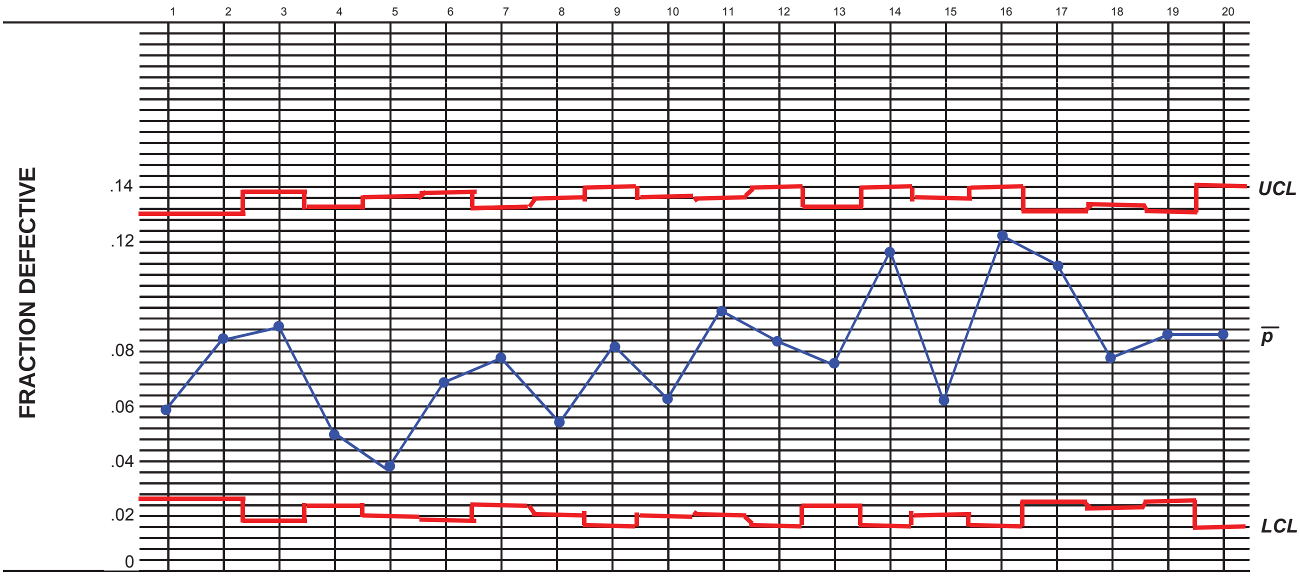


MONITORING PERFORMANCE

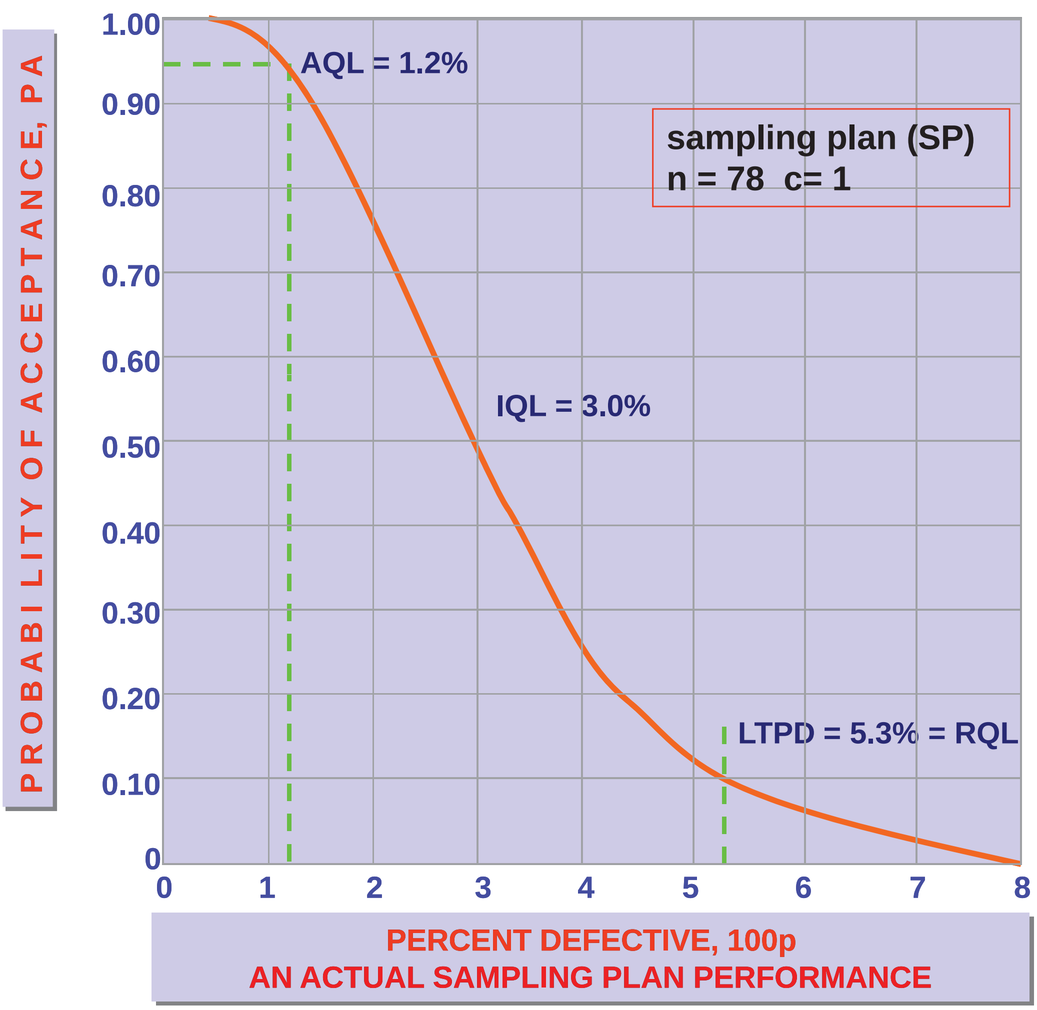
DEFECTIVE CONTROL CHART (p)

PRODUCT	OPERATION	REJECT TYPE	1	2	3	4	5	TOTAL
OPERATORS	MACHINE	CONTROL LIMITS						

DATE	7/4	7/11	7/18	7/25	8/1	8/8	8/15	8/22	8/29	9/5	9/12	9/19	9/26	10/3	10/10	10/17	10/24	10/31	11/7	11/14
SAMPLE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1. **emission**	6	11	8	6	3	5	8	7	7	7	4	8	6	8	7	13	14	9	11	9
2. **handling**	5	6	4	5	2	2	5	2	1	3	10	3	9	4	2	4	8	2	5	5
3																				
4																				
5	3	3	4	1	2	6	3	2	6	2	4	4	2	7	3	4	3	5	4	1
TOTAL DEFECTIVE	14	20	16	12	7	13	16	11	14	12	18	15	17	19	12	21	25	16	20	15
SAMPLE SIZE: n	240	238	183	221	190	187	210	202	176	187	190	182	227	162	199	174	228	214	233	174
FRACTION DEF. p	.058	.084	.087	.054	.037	.070	.076	.054	.080	.064	.095	.082	.075	.117	.060	.121	.110	.075	.086	.086
NOTES																				



Module-3 ACCEPTANCE SP



SAMPLE ANALYSIS

For sampling plan n = 78 c= 1

AQL = Acceptable Quality Level in the example = 1.2 % at the 95% probability of acceptance (pa)

IQL = Indifference Quality Level = 3%

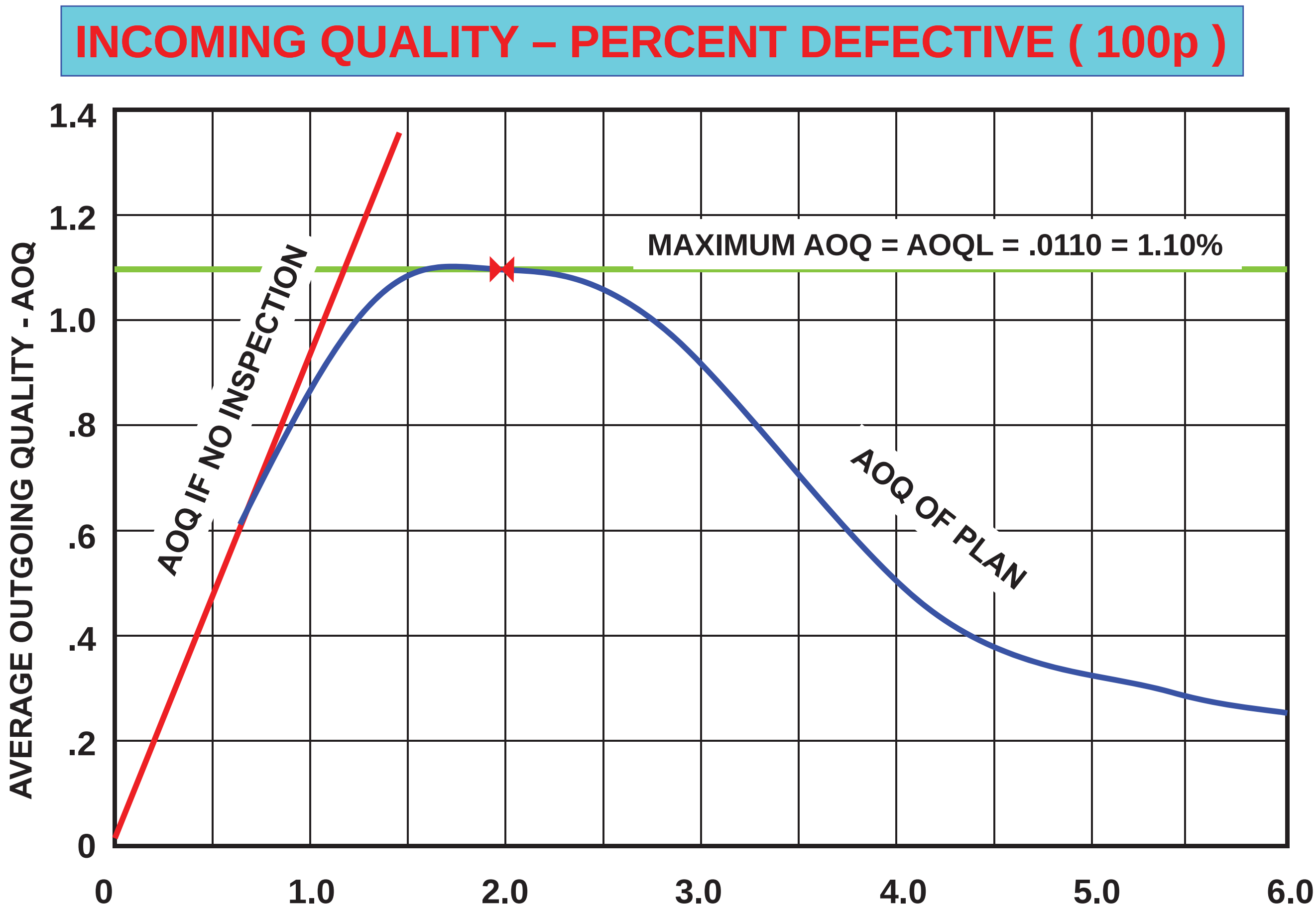
LTPD = Lot Tolerance Percent Defective = 5.3% or

RQL = Rejectable Quality Level = 5.3%

COMPUTATIONS FOR AVERAGE OUTGOING QUALITY LIMIT (AOQL) FOR THIS EXAMPLE, n=78. C=1

INCOMING QUALITY FRACTION DEFECTIVE = *p*	np	PROBABILITY OF ACCEPTANCE= *pa*	AVERAGE OUTGOING QUALITY (AOQ) = *p x Pa*
0.005	0.39	0.940	0.00470
0.010	0.78	0.820	0.00820
0.015	1.17	0.680	0.01020
0.020	1.56	0.550	0.01100
0.025	1.95	0.430	0.01075
0.030	2.34	0.330	0.00990
0.035	2.73	0.250	0.00875
0.040	3.12	0.190	0.00760
0.045	3.51	0.140	0.00630
0.050	3.90	0.100	0.00500
0.055	4.29	0.075	0.00402
0.060	4.68	0.050	0.00300

AOQL = MAXIMUM AOQ = 0.01100=1.1%



AOQ curve and AOQL for a typical sampling plan.

Dodge Romig – Average Outgoing Quality and Average Outgoing Quality Limit (AOQL)

SAMPLE ANALYSIS

For sampling plan n = 78 c= 1

- **: At pa = 94% lot containing 0.5% defective was accepted.**
- **Therefore (.94) x (0.5) = 0.47% defectives are contained in the accepted lot.**
- **All defectives in rejected lots (6%) are 100% inspected, defectives removed and good ones returned to the good lot.**

Dodge Romig – Average Outgoing Quality and Average Outgoing Quality Limit (AOQL)

SAMPLE ANALYSIS

For sampling plan n = 78 c= 1

:AVERAGE OUTGOING QUALITY LIMIT (AOQL)

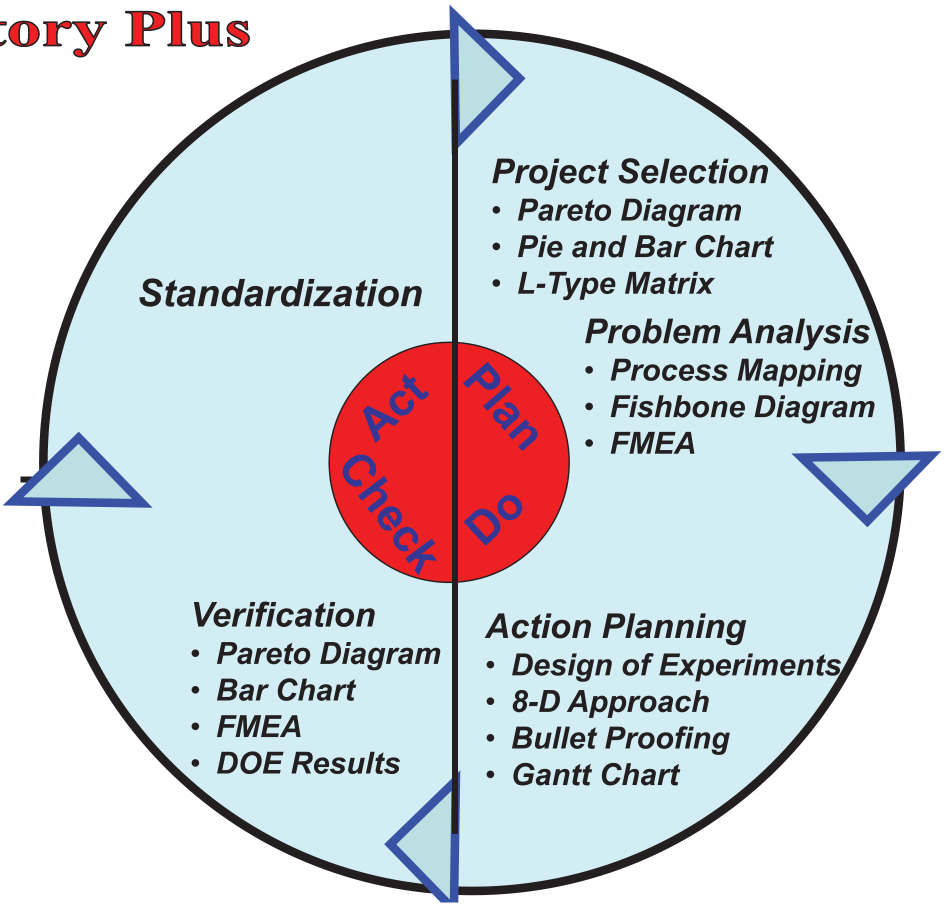
55% x 2.0% = 1.1% defectives (AOQL) = the highest % defective.

45% defective lot is 100% inspected, defectives removed; good lot (no defect) are returned to the good lot.

MODULE - 4 PROBSOLVE

Methodology and Techniques

QC Story Plus



PROBLEM IDENTIFICATION*

Problem	Impact to yield(40%)	Occurrence (30%)	Solvability (30%)	Total	Rank
Damaged & broken wire	30	25	25	80	1
Cracked &Chipped Die	25	20	25	70	2
Cracked &Chipped Substrate	15	10	25	50	4
Smeared Die	20	15	25	60	3

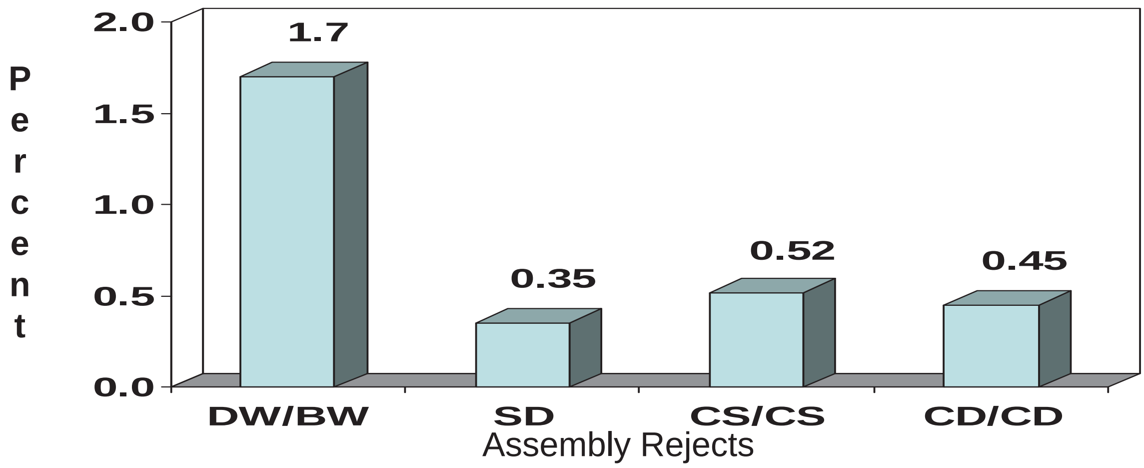
Criteria:

Impact		Occurrence		Solvability	
1 – 9%	Very low	1 - 10%	Rare	0 %	Hard to Solve
10 – 19%	Low	11 - 20%	Seldom	30%	Easy to solve
20 – 29%	High	21 - 30%	Always		
30 – 40%	Very high				

*PHILIPS EXPERIENCE

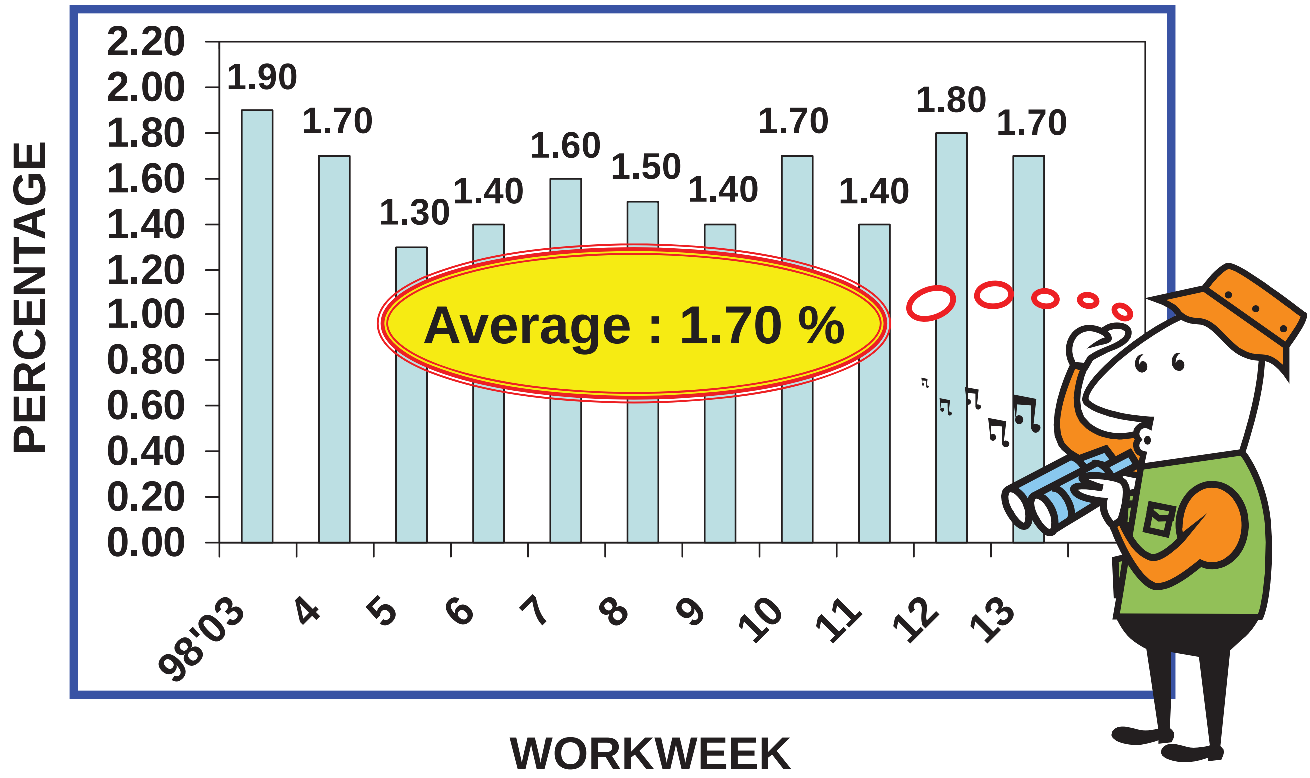
TOP FOUR (4) ASSEMBLY REJECTS

Assembly Rejects	Jan.	Feb.	Mar.	Apr.	Ave.
Damaged Wire (DW) / Broken Wire (BW)	1.5	1.6	1.6	1.9	1.70
Smeared Die (SD)	0.02	0.50	0.30	0.40	0.35
Chipped Substrate (CS)/ Cracked Substrate (CS)	1.1	0.03	0.30	0.40	0.52
Chipped Die (CD) / Cracked Die (CD)	0.40	0.40	0.50	0.50	0.45



1998 WEEKLY REJECTION RATE

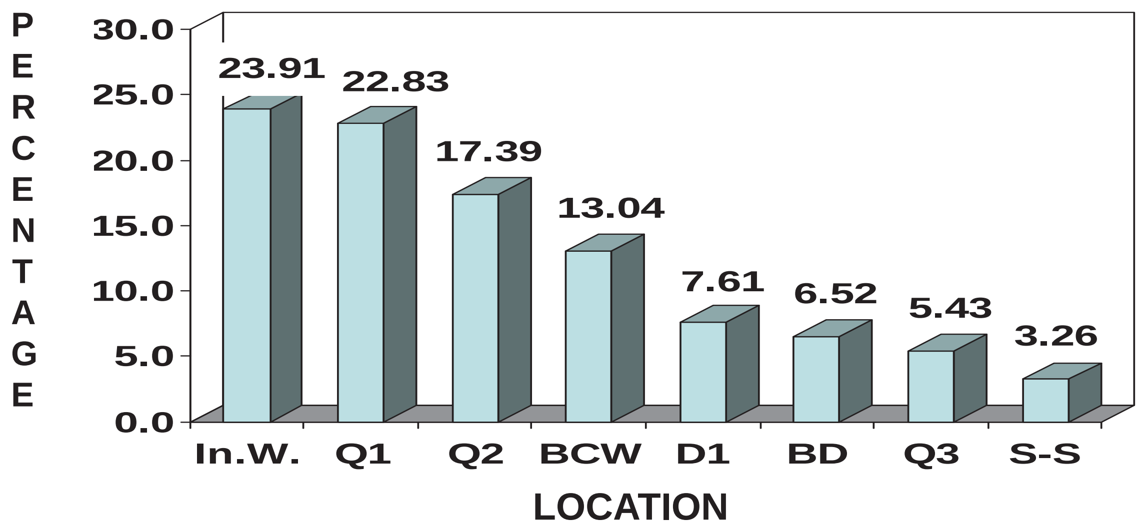
(Damaged and Broken Wire)



LOCATION OF OCCURENCE

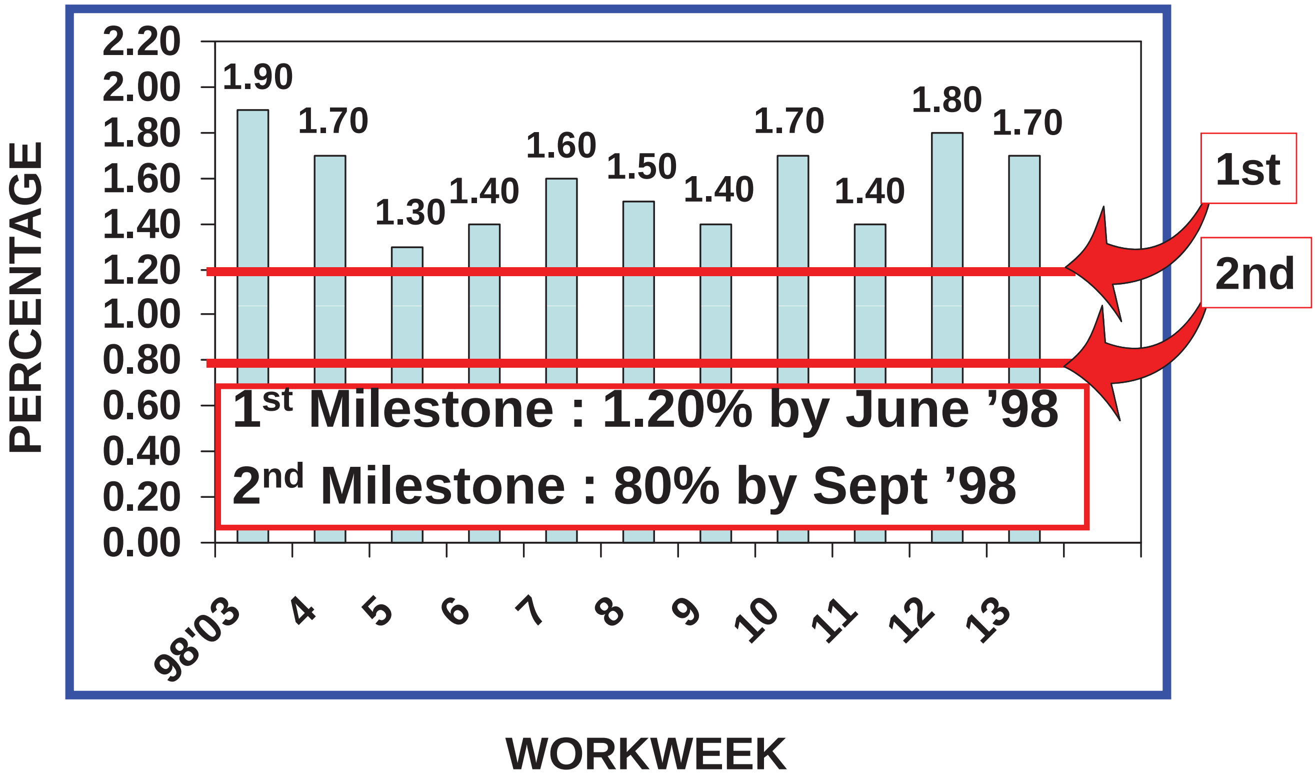
(Damaged Wire / Broken Wire)

LOCATION	IN.W.	Q1	Q2	BCW	D1	BD	Q3	S-S	Total
PCS.	22	21	16	12	7	6	5	3	92
%	23.91	22.83	17.39	13.04	7.61	6.52	5.43	3.26	100.00



LOCATION OF OCCURENCE

(Damaged and Broken Wire)



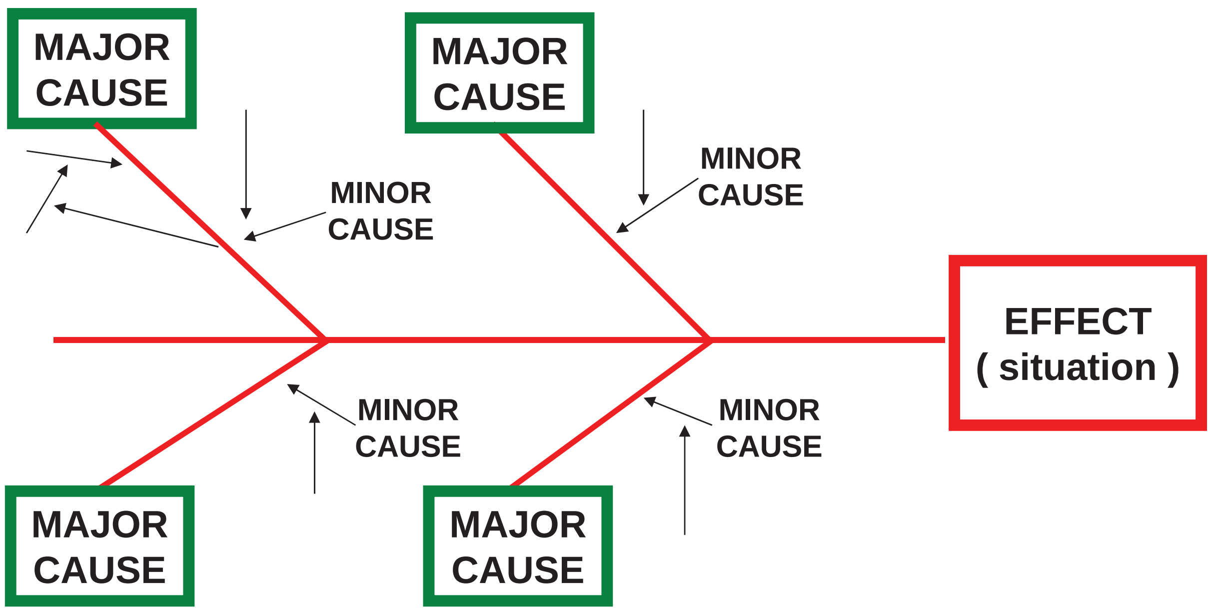


Figure 3.3 . Example of Cause-and-Effect Diagram for Version A approach where major causes have yet to be brainstormed.

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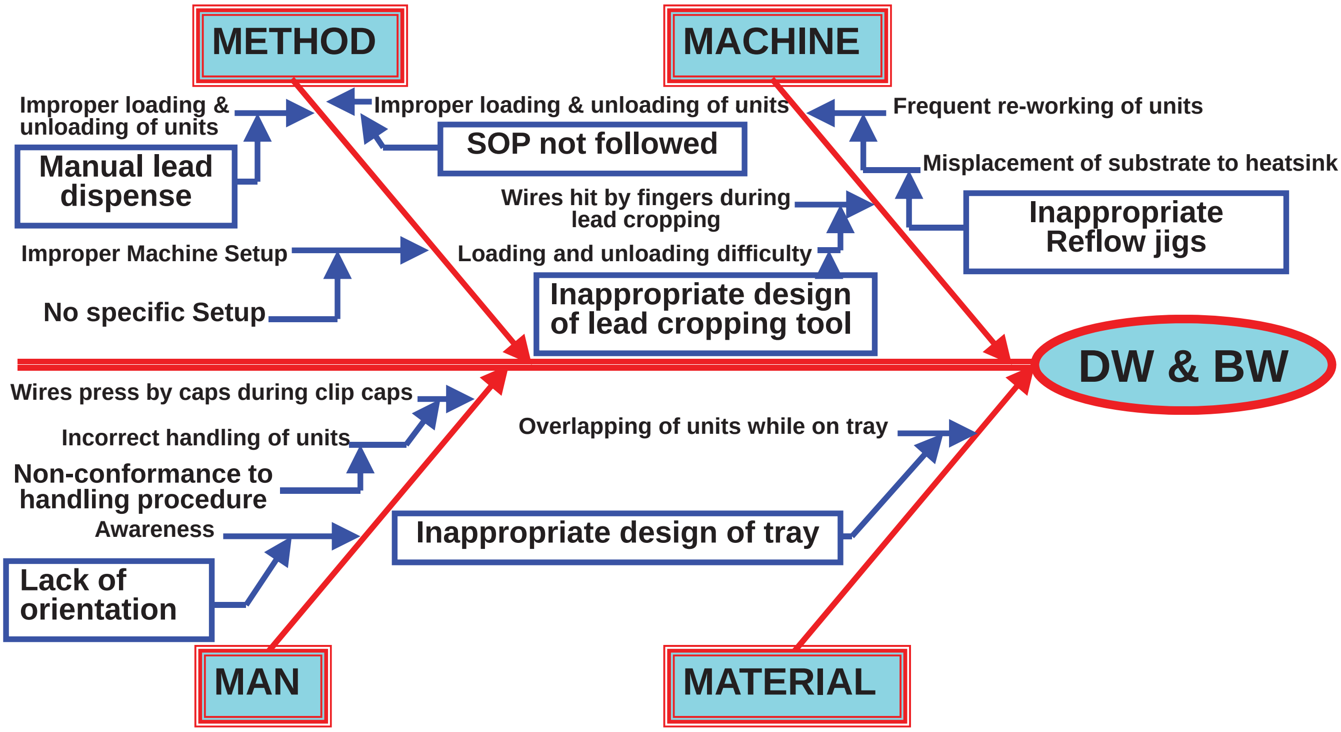
PROBLEM ANALYSIS



FISHBONE DIAGRAM

MMG'S 7DS IN EXPERIMENTAL DESIGNING*

MODULE - 5 DOE

D1 = DEFINE THE PROBLEM

↓

D2 = DETERMINE OBJECTIVES

↓

D3 = DEVELOP EXPERIMENTAL PLAN

↓

D4 = DO THE EXPERIMENT

↓

D5 = DESCRIBE RESULTS

↓

D6 = DERIVE CONCLUSIONS

↓

D7 = DEVELOP ACTION PLANS

*MMG = MIFLORA M.GATCHALIAN

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7- DRIVERS TO EXPERIMENTATION

1. PRESSURE FOR GROWTH
2. ACCELERATING PACE OF CHANGE
3. VULNERABILITY OF CHANGING CONDITIONS AND TRENDS
4. FORECASTING PERSONNEL REQUIREMENTS OF THE COMPANY
5. CRYSTALLIZATION OF THE COMPANY’S MISSION AND VISION
6. FORCES A SYSTEMATIC REVIEW OF COMPANY STRENGTHS AND WEAKNESSES
7. BENEFICIAL EFFECT ON MOTIVATION

TYPES OF EXPERIMENTS BY INCREASING LEVEL OF FORMALITY

VERY INFORMAL

1. **Trial and error methods**
   Introduce a change and see what happens
2. **Running special lots or batches**
   Produced under controlled conditions
3. **Pilot runs**
   Set up to produce a desired effect
4. **One-factor experiments**
   Using a control chart to experiment on a process
5. **Planned comparison of two methods**
   Blocking variables are considered in the plan
6. **Experiment planned with 2 to 4 factors**
   Study separate effects and interactions
7. **Experiment with 5 to 20 factors**
   Screening studies
8. **Comprehensive experimental plan with many phases**
   modeling, multiple factor levels, optimization

VERY FORMAL

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PHASES OF EXPERIMENTATION

PHASE I
CONCEPTUALIZE

↓

PHASE II
SCREEN IDEAS

↓

PHASE III
BUILD THE MODEL

↓

PHASE IV
VERIFY OUTPUTS

USES OF EXPERIMENTAL DESIGNS

1. TO CHARACTERIZE A PROCESS

2. TO TROUBLESHOOT A PROBLEM

3. TO QUANTIFY ERRORS

EXPERIMENTAL DESIGNS

Completely Randomized Design (CRD)

Completely Randomized Block Design (CRBD)

1- Factor at a Time (1- FAT) Design

Factorial designs at two levels (2^K)
where K = number of factors

Mixture Designs - Formulations with 3 major components

1-factor at a time (1- FAT) Experimental Design Matrix

Trial	Treatment				Total
	L_0	L_1	L_2	L_3	
1	X_{11}	. . .	X_{13}		$X_{.1}$
2	.			X_{24}	
3	.	X_{32}			
4	.			X_{ij}	
	$X_{1.}$		. . .		$X_{..}$

SIMPLE DESIGN OF EXPERIMENT- SAMPLE OF 1- F.A.T.

Completely Randomized Design (CRD) Model

$$X_{ij} = m + t_i + e_{ij}$$

Where:

m = main effect

t_i = treatment effect

e_{ij} = residual or error

Set-up the hypothesis:

Ho: $Uo = U_1 = U_2 = U_3$

HA: $Uo \neq U_1 \neq U_2 \neq U_3$

Alpha = 5%

The Analysis of Variance (ANOVA) Table for CRD (1-FAT)

Source of variation	Degree of freedom	Sum of Squares	Mean square	Fc	Ft
Treatment	3	10.282	3.42	0.22	3.49
Error	12	187.131	15.59		
Total	15	197.413			

Criteria: If Fc $\leq$ Ft : Accept the Ho

If Fc > Ft : Reject the Ho

F2	F1 -	F1 +
-	- -	- +
+	+ -	+ +

2^2 Design (4 cells)

F2	F3 -		F3 +	
	F1 -	F1 +	F1 -	F1 +
-	---	+- -	--+	+- +
+	-+ -	+-+	-++	+++

2^3 Design (8 cells)

F4	F2	F3 -		F3 +	
		F1 -	F1 +	F1 -	F1 +
-	-	----	+---	--+-	+- + -
	+	-+--	-+- -	-+ +-	++ +-
+	-	---+	+--+	--++	+-++
	+	-+-+	++-+	-+++	++++

2^4 Design (16 cells)

Hierarchical design presentations of 2,3, 4 Factors at two levels

FACTORIAL EXPERIMENT AT 2^3

A. RESPONSE VARIABLE	MEASUREMENT TECNIQUE
MEASURE OF SHADE	OPTICAL INSTRUMENT

B. FACTORS UNDER STUDY	LEVELS	
(1) MATERIAL QUALITY	A (-)	B (+)
(2) OVEN PRESSURE `	LOW (-)	HIGH (+)
(3) OXIDATION TEMPERATURE (°C)	LOW (-)	HIGH (+)

C. BACKGROUND VARIABLES — METHOD OF CONTROL

IMPORTANT BACKGROUND VARIABLES WERE IDENTIFIED AND HELD CONSTANT.

ESTIMATING THE EFFECTS USING THE DESIGN MATRIX

Tc Yate's order Main effect Interaction

TEST	CODE	A=M	B=P	C=T	AB= MP	AC= MT	BC= PT	ABC= MPT	RESPONSE	
1	(1)	-	-	-	+	+	+	-	189	4
2	a	+	-	-	-	-	+	+	228	2
3	b	-	+	-	-	+	-	+	218	3
4	ab	+	+	-	+	-	-	-	259	5
5	c	-	-	+	+	-	-	+	195	8
6	ac	+	-	+	-	+	-	-	200	6
7	bc	-	+	+	-	-	+	-	238	1
8	abc	+	+	+	+	+	+	+	241	7
DIVISOR =4 Example: 22 = (-189 +228 -218+259-195 +200 -238+ 241)/ 4									Expt'l units	
EFFECT		22	36	-5	0	-18	6	-1		

tc= treatment combinations = 2^k where k = no. of factors; tc can be rearranged , but Yate's order has to be returned for data analysis

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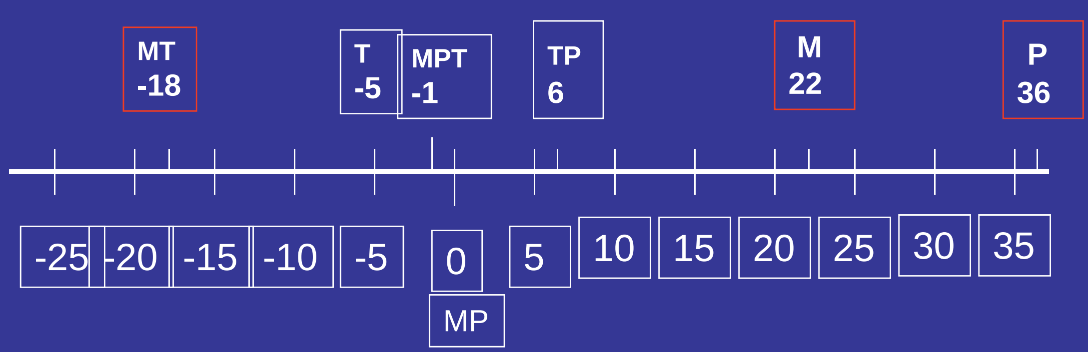
A SUMMARY OF INTERACTION EFFECTS ON THE FINAL PRODUCT

DOT DIAGRAM SHOWING IMPORTANT EFFECTS



Effects clustered near zero cannot be distinguished from nuisance variables. The plot shows that the most important factors are the effect of material (M=22), pressure (P=36) and the interaction between Material and Temperature (MT= -18).

CONCLUDING REMARKS

A PROACTIVE QUALITY ASSURANCE WILL BE ACHIEVED THROUGH STATISTICAL THINKING DEVELOPMENT BY:

1. **intensive training with hands-on experiences in the application of the STD modules since this promotes efficient and effective collection and management of data, knowledge and information;**
2. **building the capability for data handling, analysis and interpretation employing the STD modules which can also enhance controlling and monitoring of processes;**
3. **statistical thinking employees who are prepared to actively contribute, with high confidence, to continual improvement and** low-risk decision-making

THANK YOU

AND

GOOD DAY!!!