Use of P-charts to Determine if Shifts and Teams are Responsible in Producing Defective Glasses at XYZ Company

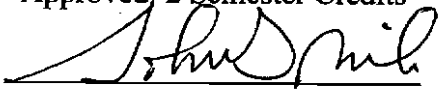
by

Swarna Shrestha

A Research Paper
Submitted in Partial Fulfillment of the
Requirements for the
Master of Science Degree
in

Technology Management

Approved: 2 Semester Credits



John Dzissah, PhD

The Graduate School

University of Wisconsin-Stout

March, 2008

The Graduate School
University of Wisconsin-Stout
Menomonie, WI

Author: **Shrestha, Swarna**

Title: ***Use of P-charts to Determine if Shifts and Teams are Responsible in Producing Defective Glasses at XYZ Company***

Graduate Degree/ Major: MS Technology Management

Research Adviser: **John Dzissah, Ph.D.**

Month/Year: **March, 2007**

Number of Pages: **46**

Style Manual Used: **American Psychological Association, 5th edition**

ABSTRACT

Quality problems are observed in all the industries. It negatively affects productivity, brand image and financial statement of the company. Quality gurus such as Deming and Juran realized the impact of quality problem in the industry. They have developed numerous theories and tools to prevent quality problems. It is rampantly used in all over the globe.

XYZ is facing difficulty in controlling the defects. It is affecting their productivity. Therefore, the company decided to investigate if the teams and shifts are responsible in producing defects.

The purpose of the study is to use p-chart, one of the quality tools to analyze the defect rates produced by teams in their corresponding shifts while manufacturing glasses of different thickness. The tools will the use data accumulated by the quality control department.

The researcher will draw conclusion on the basis of p-chart developed. The p-chart will be created for the defects produced by every team when producing glasses of different thickness. Based on the findings, the researcher will draw conclusions and recommend appropriate actions.

The Graduate School

University of Wisconsin Stout

Menomonie, WI

Acknowledgments

First and foremost, I would like to thank my parents for their encouragement and support throughout my education in the University of Wisconsin.

I would also like to thank my advisor John Dzissah, PhD at the University of Wisconsin, who provided me with support, ideas and encouragement to help me complete this project. I sincerely appreciate the comments and suggestions that have proven invaluable for my project. Special thanks also goes to the university for the support extended.

TABLE OF CONTENTS

List of Figures

Chapter I: Introduction

XYZ is a glass manufacturing company. The manufacturing plant operates around the year. They manufacture glasses with various thicknesses ranging from 2.2 millimeter (mm) to 5.7 mm. The company operates with three teams in two shifts for its manufacturing processes. The teams are scheduled to work at either the night or the day shift. All the teams are required to manufacture glass of different thicknesses at their shifts depending on the demand.

Statement of the Problem

XYZ is faced with the following quality problems:

- Defects
- Out of thickness
- Slug
- Trim
- Layout
- Bad cut
- Snap fail

These problems have persisted over the past years resulting into lost of productivity and unsatisfied customers. Defects are observed to occur randomly during the manufacturing process. This may be due to variety of factors like human error, raw materials, inappropriate machinery, environmental factors or process error. The company would like to identify the factors responsible for the quality defects. This research work will focus on studying the work output from teams responsible in manufacturing glasses of difference thickness at their

shifts. The work output will be analyzed using control chart analysis on data collected over the period of three months to determine if shifts and teams are responsible for the defects. The findings will help the company initiate necessary corrective measures to ensure that their defect rates are within the allowable industrial standards.

Purpose of the Study

The purpose of the study is to identify if the teams and shifts are the responsible factors of defects. The study will analyze the percent of defects created by the teams in their shifts while manufacturing glasses of different thickness. Based on the analysis the study will recommend measures the company XYZ should implement or provide further investigation proposals to eliminate defects.

Research Objectives

1) To determine if the teams are responsible for the defects.
2) To determine if the shifts are responsible for the defects.
3) To determine if the thickness of the glasses is responsible for the defects.
4) Provide recommendations to XYZ Company.

Significance of the Study

The study is important to the Production and Quality Control Department of the XYZ glass manufacturing company for the following reasons;

1) To determine the factors contributing to the defects and the right fix can be made.
2) To minimize or eliminate the costs resulting from defects.
3) To determine the best combinations of teams, defects and thickness to produce glasses with minimum defects.
4) Facilitate to find and fix the root cause of manufacturing defects.

Assumptions of the Study

1) The data collection process adopted by XYZ Company is accurate.
2) The data provided by XYZ is correct.
3) Team members were not interchanged.
4) The company has qualified personals to understand control charts.
5) The subgroup size of 300 used by the company to collect the data is appropriate.

Limitations of the Study

1) The study is based on the three months data.
2) Only data of teams that have manufactured the glasses with the specific thickness for four or more times during the period is considered.
3) The study is limited to XYZ Company.
4) The study performs p-chart analysis to identify the responsible factors for the defects.
5) The study is limited to teams, shifts and thickness.

Definition of Terms

p-chart: A p-chart is one of the types of control chart used to determine if the process is stable or predictable. It plots the percentage of nonconformities rather than the actual number of nonconformities.

Shift: Shift is a predetermined starting and ending work time. They are generally categorized as night shift or day shift.

Team: Team is a group of individuals with a combination of different skills and talents working towards achieving a predefined objective.

Thickness: The thickness of glass is the layers of molten glass poured on the molten tin. The thickness is generally measured in inches or mm.

Chapter II: Literature Review

Control Charts

Control charts are statistical quality control tool developed by Dr. Walter Shewart in 1924. It was widely used for production in 1940s during the war era. It uses graphs to determine if the process requires adjustments to ensure that the final products are in compliance with the specifications. Control charts are graphical presentation of quality characteristics measured from samples.

It is vital for any production process to know if the products comply with the specifications. Generally there are two "enemies" of product quality: (1) deviation from target specifications, and (2) excessive variability around target specifications (Grant & Leavenworth, 1988). Dr Walter Shewat had observed the presence of two components of variation in all the manufacturing processes. They were the random variation and intermittent variation. Random variations were inherent in the process where as intermittent variations had an assignable cause. He concluded that assignable causes can be discovered and removed by the use of effective diagnostic programs whereas random causes required changes in the process.

Deming (1986) notes:

> A fault in the interpretation of observations, seen everywhere, is to suppose that every event (defect, mistake, accident) is attributable to someone (usually the one nearest at hand), or is related to some special event. The fact is that most troubles with service and production lie in the system. (p.204)

Deming adds:

> Confusion between common causes and special causes leads to frustration of everyone, and leads to greater variability and to higher costs, exactly contrary to what is needed. I

> should estimate that in my experience most troubles and most possibilities for improvement add up to proportions something like this: 94% belong to the system (responsibility of the management), 6% special. (p. 67)

When to Use a Control Chart

The use of control chart provides a study of variation and its sources. Control charts can give information of not only process monitoring and control but also direction for improvements. Control charts identify the presence of special or common cause variations in the process so that appropriate actions could be reinforced. Control charts are used:

- If the current process requires continuous improvement by identifying the causes of the problems.
- To forecast the range of the process.
- To determine the process stability.
- To assign common or special variation to the patterns of the process.
- Facilitate in decision making to identify if the process require significant changes or aim at solving a particular problem.

Components of a Control Chart

A typical control chart consist eight elements. Each of the elements is import as it plays a significant meaning in interpreting the charts.

1. Title: The title indicates the information that is on display on the chart.
2. Legend: It provides the information about how and when the data was accumulated.
3. Data collection section: It is the basket of the collected data. All the data used in the control chart is found in this section.

4. Plotting areas: The data of the data collection section are plotted in this section. It provides a visual pattern of the graphs for interpretation.
5. Vertical or Y-axis: Y-axis represents the magnitude of the data being analyzed. Variable data are shown in scale of measurements where as attribute data shown in frequency or percentage.
6. Horizontal or X-axis: The horizontal axis show the data sequentially that is recorded in the data collection section.
7. Control limits: Every control chart consisted of two control limits namely the upper control limit (UCL) and the lower control limit (LCL). It is represented by a horizontal line. Each one of it is three sigma distance from the centerline. UCL is three sigma distance higher than the centerline whereas LCL is three sigma distances lower to the centerline. Values of UCL and LCL depend on the type of control chat. Different control charts use different formulas in calculation the control limit values.
8. Centerline: Centerline is the average value of the data collected. It is represented by a horizontal line and is located between the ULC and LCL.

Interpreting Control Chart

It is essential to interpret the control charts in a correct way. Misinterpretation could lead to blaming people for problems that they cannot control, spending time and money looking for problem that do not exist, spending time and money on process adjustments or new equipment that are not necessary, taking actions where no action is warranted and asking for worker-related improvements where process of equipment improvements need to be made first (Summers, 2006).

The process is considered to be in a state of control, or under control, when the performance of the process falls within the statistically calculated control limits and exhibits only chance, or common, causes (Summers, 2006). Points in the control chart show randomness. A stable process is an indication that a variation within the process is predictable. Evans Lindsay (2002) states that the following checklist provides a set of guidelines to determine whether the process is in control:

1. No points are outside control limits.
2. The number of points above and below the center line about the same.
3. The points seem to fall randomly above and below the center line.
4. Most point, but not all, are near the center line, and only a few are close to the control limits.

Interpreting Patterns in Control Chart

Unstable process display patterns in the control chart. These patterns require root cause analysis to assign an assignable cause so that the process can be brought back to a control state. Data from the out of control process display one of the following patterns:

Trends. Trends are cases when the cause gradually affects the output of the process. The points on the control chart steadily move up or down the control line. Decreasing trends are positive sign towards process stability. Improved operator skill or work method, better materials, or improved or more frequent maintenance results to decreasing trend.

Hugging the Center Line. The situation occurs when the data points lies close to the centerline. The common cause of this pattern is the mistake of abstracting a sample item from each of several machines. The pattern can be avoided and more accurate analysis could be performed if control chart of individual machine, shift, operator etc. is constructed.

Hugging the Control Limits. The pattern arises when most of the sample points fall near to the control limit line. This most probable cause for the display of such pattern is when lots material is used in one process or when products manufactured by different machines are taken as a sample.

Instability. Random display of sample point in the control chart reflects instability. In such cases some points can be observed to fall outside the control limits. This pattern indicates that the process requires immediate attention. Sample collected for machine undergoing tuning process could result to such pattern.

Sudden Shift in the Process Average. The pattern will emerge when majority of sample falls in one side of the center line. This is a result of external influence in the process. James and William (2002) states three rules of thumb for early detection of process shift:

1. Eight consecutive points fall on one side of the center line.
2. Divide the region between the center line and each control limit into three equal parts. Then if:

- Two of three consecutive points fall in the outer one-third region between the center line and one of the control limits or
- Four of five consecutive points fall within the outer two-thirds region.
- Recurring cycles: The pattern display short repetition in the chart. They are caused by systematic changes related to process. The pattern could sometimes be difficult to detect as the entire cycle may not be included in the single chart.

Types of Control Charts

Control charts are created depending on the sample data. The date data type can be of two types: (1) variable data and (2) attribute data. Variable data reflect the actual measurements. The

variable chart represent the measurable characteristics of the product like height, weight etc. The most commonly used control charts for variable data are X-bar and R chart, X-bar and S chart, moving average – moving range chart (MA–MR chart), target chart, cumulative sum chart, exponentially weighted moving average chart and multivariate chart.

Attribute data demonstrates the total numbers that are either complaint or noncompliant. The either confirms to the specifications or fails to confirm. They are counted hence it cannot have fractions or decimals. Attributes data are usually easy to collect. It is often done by visual inspection or automation. The most common control chart used for attribute data is the p chart. It studies the process over a period of time. P chart monitors the proportion of rejects as non confirming to specifications, in a lot. It is extensively used to monitor quality characteristics providing management with records of quality history. It is proven that introduction of p chart in the process has resulted in quality improvement.

Designing Control Charts

According to James and William (2002), designers of control chart must consider four issues: (1) the basis of sampling, (2) the sample (n) size, (3) the frequency of sampling, and (4) the location of the control limits.

The Basis of Sampling. Samples should be chosen to be as homogeneous as possible so that each sample reflects the system of common causes or assignable causes that may be present at that point in time. That is, if assignable causes are present, the chance of observing differences between samples should be high, while the chance of observing differences with a sample should be low.

Sample Size. The sample size is important because it represents the state of control at the time the sample was abstracted. Attribute data require large sample size to get correct results.

The sample size is normally greater than 100. Appropriate sample size is important because colleting large number of sample could mean more money, time loss and waste of resources whereas small sample size results to inaccurate outcomes.

Sampling Frequency. Taking large samples randomly and frequently is desired. There is no specific rule for the frequency of sampling. However close samples provide an opportunity to detect changes in process characteristics as soon as possible and reduce the chances of producing large amount of nonconforming product.

Location of Control Limits. Location of control limit is important to make an accurate assessment about the state of control. The wider control limit prevents the sample points from falling outside the limits preventing incorrect conclusion that a special cause is present when in fact one does not exist. These errors will lead to unnecessary investigation for an assignable cause, including costs of lost production time and special testing.

Chapter III: Methodology

The objective of this chapter is to detail the methods and procedures used in this research. The methodology used in this research work is the analysis of data provided by the XYZ manufacturing company using p-charts. The p-chart of defect rate in each shift created by the teams when manufacturing glasses of different thickness will be constructed. The research will draw conclusions and make recommendations based on the outcome of p-charts. The goal of this study is to determine the possible relationship between the defect rate with respect to the teams and shifts in manufacturing glasses of different thickness at the XYZ glass manufacturing company.

Data Collection

The characteristic designated for the study is defect. The research has used the data provided by the XYZ Company. Defects on glasses of different thickness that were produced in batches depending on the demand were recorded. Sample size (n) of 300 was randomly selected for every thickness produced. The number of nonconformities (np) found were recorded.

Calculating fraction nonconforming (p)

After each sample was taken and inspections complete, p of each sample is calculated using n = 300 and recorded np. p = (np)/n

Plotting p on the Control Chart

The p values of each of the sub group are plotted in the p-chart. The scale on the p chart reflects the magnitude of the data. It is detonated by dots in the chart.

Calculating the Centerline and Control Limits

The centerline for each glass thickness is the average value of its p. The np values are added and are divided by the total number of n. The centerline is represented by p-bar in calculation and chart.

$$\text{p-bar} = \sum_{i=1}^{n} np \,/\, \sum_{i=1}^{n} n$$

The control limits for the p-chart is calculated using the formulas:

$$\text{Upper control limit (UCLp)} = \text{p-bar} + 3\frac{\sqrt{\text{p-bar}\,(1-\text{p-bar})}}{\sqrt{n}}$$

$$\text{Lower control limit (LCLp)} = \text{p-bar} - 3\frac{\sqrt{\text{p-bar}\,(1-\text{p-bar})}}{\sqrt{n}}$$

The LCLp is rounded to zero on occasions when the calculated values of LCLp were observed to be negative.

Drawing p-bar and Control Limits on the Chart

Solid line is used to represent the p-bar, LCLp and LCLp.

Interpreting the Charts

The p values in the charts were observed to see if:

- Any one sample point outside the control limit line.
- Eight continuous sample points on either side of the centerline.
- Two of three consecutive points outside the 2-sigma warning limits but still inside the control limits.
- Four of five consecutive points beyond the 1-sigma limits.
- A definite pattern of the sample points such as cyclic, upward or downward trend.
- Several points near the control limit line.

If any of the charts demonstrated the above stated characteristics, the process will be recommended for further investigation to find the root cause.

Limitations

- The study is based on the three months data.
- Only data of teams that have manufactured the glasses with the specific thickness for four or more times during the period is considered.
- The study is limited to XYZ Company.
- The study performs p-chart analysis to identify the responsible factors for the defects.
- The study is limited to teams, shifts and thickness.

Chapter IV: Results

The objective of this chapter is to provide an analysis and interpretation of the P-charts developed from the data. These P-charts represented the variability in the proportion of components with defects that were produced. The P-charts were divided according to the following variables:

- Shift (Day or Night)
- Team (A, B, C or D)
- Plate Thickness

One P-Chart for each possible combination of Shift, Team and Plate Thickness was developed.

Spotting Out of Control Processes

The upper and lower control limits provided in charts represent an area of three standard deviations around "p-bar", which represent the average defect rate over all measurements (for a particular combination of Shift, Team and Plate Thickness). Variability around the average defect rate is to be expected due to chance or common causes, as it clearly cannot be expected that the defect rate will be constant across all measurements. The Upper and Lower Control Limits provide a range in which approximately 99.5% of the observations should fall assuming that the underlying "true" defect rate is the one computed from the sample.

Therefore, the main characteristic that should be examined from a p-chart is whether any of the measurements fall outside the defined control limits. Given that such an event has a very low probability of happening assuming that the defect rate is given by p-bar, observing a measurement falling outside this range would suggest that the underlying probability of manufacturing a defective plate was significantly larger (or smaller) at the point where that

measurement was taken. This would warrant further investigation in order to uncover the causes of the unusually high (or unusually low) defect rate, is it is very unlikely that an observation so far away from p-bar happened merely by chance.

Although looking for measurements outside the control limits is most relevant way in which p-charts should be analyzed, there are other rules for detecting out of control processes. These rules are based on two notions:

No Autocorrelation. If the variations in the defect rate are merely due to chance, then we should not see long "strings" of measurements above (or below) the p-bar line. If a long string were observed, this might imply that there was a change in the process at the time of those measurements, and it is likely that the probability of producing a defective piece was significantly different during that period as compared to the periods were the other measurements were taken (for example, this might be observed if different machines were alternatively used to produce similar pieces, and the machines had different probabilities of producing defective pieces).

The probability of making a measurement at any given point should be inversely related with distance between that point and the p-bar line. This is, of course, the underlying concept when looking for points outside the control limits (i.e. very "far away" from the p-bar line). As mentioned earlier, the control limits constitute a range of three standard deviations around the p-bar line. However, it should be noted that it is also relatively unlikely to see observations more than two standard deviations away from the p-bar line (the probability of this is should be approximately 5%), or more than one standard deviation away from the p-bar line (the probability of this is should be approximately 30%). Therefore, although making only one observation (among many others) between three and three standard deviations away from the p-

bar line is not very unlikely, observing a "string" of measurements in this area is indeed very unlikely, and should be an indication that the process is out of control.

The following chart[1] illustrates the idea of different "zones" in a control chart. As can be seen, Zone A represents the area between two and three standard deviations away from p-bar, Zone B represents area between one and standard deviations away, and Zone A represents the area less than one standard deviation away.

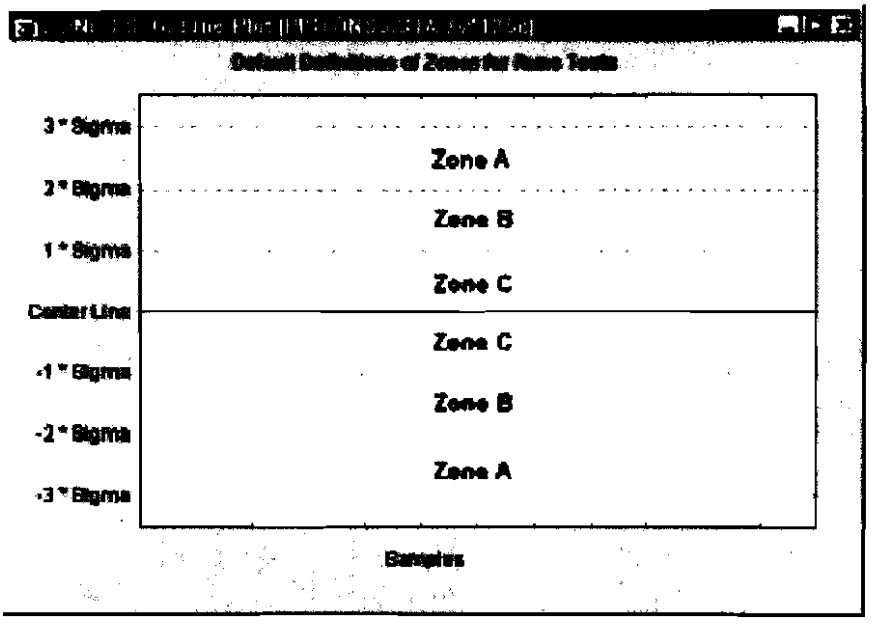


Figure 1. Zones Stg: Line Plot

(http://sunsite.univie.ac.at/textbooks/statistics/stquacon.html#variables)

From the discussion above, it is clear that observations in Zone A are relatively less likely than observations in Zone B, which are in turn relatively less likely than observations in Zone C. The following rules can be used in order to detect an out of control process based the two notions described previously:

Nine points in Zone C or beyond (on one side of central line). If this test is positive (i.e., if this pattern is detected), then the process average has probably changed.

Six points in a row steadily increasing or decreasing. This test signals a drift in the process average. Often, such drift can be the result of tool wear, deteriorating maintenance, improvement in skill, etc. (Nelson, 1985).

Fourteen (14) points in a row alternating up and down. If this test is positive, it indicates that two systematically alternating causes are producing different results. For example, one may be using two alternating suppliers, or monitor the quality for two different (alternating) shifts.

Two out of three points in a row in Zone A or beyond. This test provides an "early warning" of a process shift. Note that the probability of a false-positive (test is positive but process is in control) for this test in X-bar charts is approximately 2%.

Four out of five points in a row in Zone B or beyond. Like the previous test, this test may be considered to be an "early warning indicator" of a potential process shift. The false- positive error rate for this test is also about 2%.

Fifteen points in a row in Zone C (above and below the center line). This test indicates a smaller variability than is expected (based on the current control limits).

Eight points in a row in Zone B, A, or beyond, on either side of the center line (without points in Zone C). This test indicates that different samples are affected by different factors, resulting in a bimodal distribution of means. This may happen, for example, if different samples in an X-bar chart where produced by one of two different machines, where one produces above average parts, and the other below average parts.

The p-charts were examined for points outside the control limits and for all patterns mentioned above. Results showed "outlier" observations (i.e. observations outside of the control limits of the charts) in only three of the provided charts. These are presented as follows:

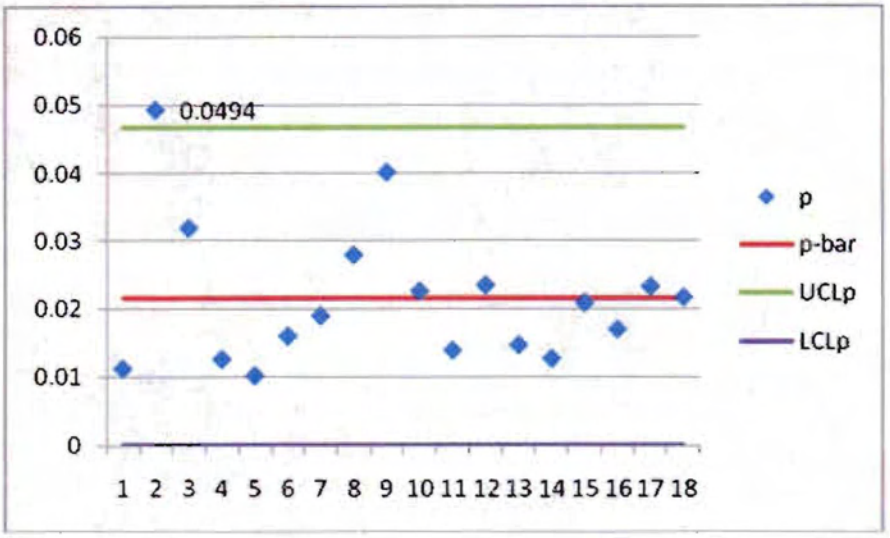


Figure 2. Team A, Day, Thickness = 3.1

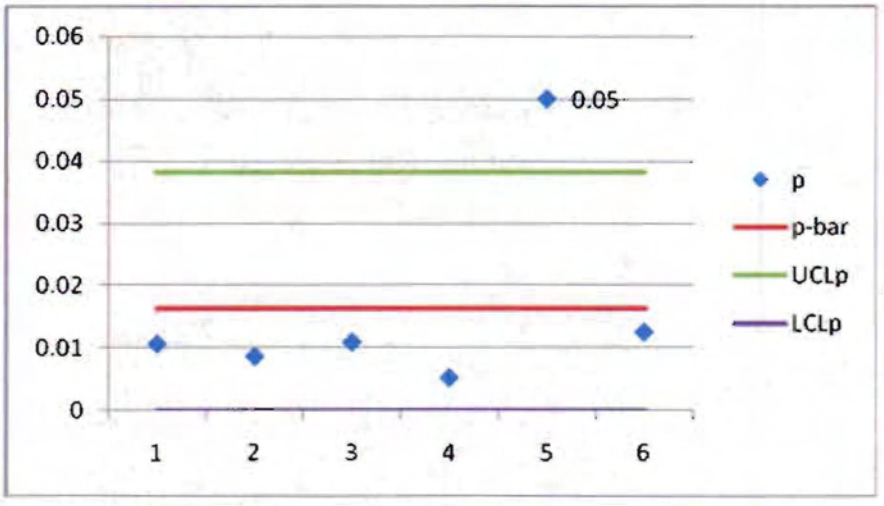


Figure 3. Team C, Day, Thickness = 3.0

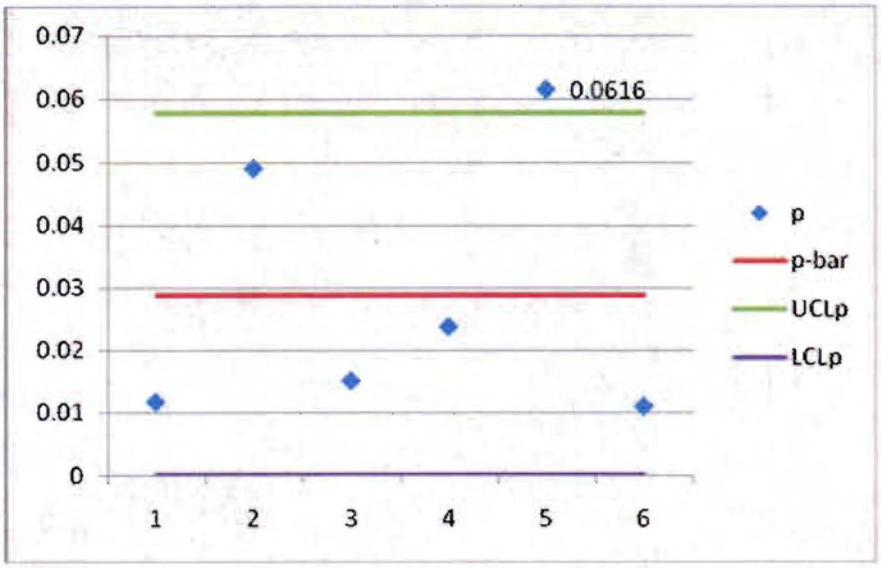


Figure 4. Team B, Night, Thickness = 3.9

On the other hand, *none of patterns related to Zones were observed.* Therefore, the only processes which should be investigated as potential candidates for being out of control would be:

- Team A, Day Shift, Thickness = 3.1
- Team B, Night Shift, Thickness = 3.9
- Team C, Day Shift, Thickness = 3.0

In all three cases, the defect rate in one of the measurements was above the upper control limit for the defect rate. The fact that measurements outside of the control limits were found does not immediately imply that these processes are out of control. Instead, these results consistute an indication that they should be further investigated. Design of Experiments should be performed in order to investigate the causes that led to the unusually high defect rates that were observed in these cases.

In order to assess whether there were significant differences among the groups, shifts, or a relationship between plate thickness and defect rate, an Analysis of Variance (ANOVA) was

performed. This analysis allows determining the impact of one or more factors on some outcome variable. In this case, the outcome variable would be the defect rate. There are three factors in this particular analysis:

- Shift (Day or Night)
- Team (A, B, C or D)
- Plate Thickness

The outcome variable in this case would be the defect rate. Therefore, results of this analysis should allow determining:

- Whether there are significant differences in terms of defect rates between day and night shifts.
- Whether there are significant differences in terms of defect rates across teams
- Whether there is a relationship between plate thickness and defect rate

It is easy to see that results from this analysis could be very useful in determining whether any changes to the processes are needed. For example, if Team A turned to be significantly better than the other teams, then leaders from the other teams might want to learn from his or her competencies in order to improve the defect rate of their own team.

Results from the ANOVA were as follows:

- There were no significant differences across Teams in terms of defect rates (p = 0.261)
- There were no significant differences across Shifts in terms of defect rates (p = 0.202)
- There was a significant (but very weak) relationship between thickness and defect rate (b = 0.002, p = 0.001).

Results thus suggest that all teams are performing equally well in terms of defect rates. Moreover, there are no significant differences in defect rates between the Day and Night Shift. The only significant result was that of Thickness. It was found that, as thickness increased, the defect rate increased as well. However, the relationship was somewhat weak. Each 1-unit increase in plate thickness was associated to a 0.2% increase in the defect rate. So, for example, it is expected that the defect rate when producing pieces with plate thickness of five units thick is 0.4% higher than the defect rate when producing piece with plate thickness of three units.

These results thus imply that the company might want to focus its attention on improving the processes for producing thicker pieces. If given the current technology level, the positive relationship between plate thickness and defect rate is to be expected, there is likely nothing the company can do in order to address these differences in defect rates. However, if there is no "fundamental" reason to get higher defect rates when producing piece with higher plate thickness, then the company should investigate the causes of this relationship. For example, it is possible that thicker pieces need a higher skill level on part of the workers, and thus the company might want to introduce training programs in order to equip its workers with better skills, thereby reducing the defect rates for thicker pieces.

Chapter V: Discussion

Evidence of out of control processes were found only in three instances:

- Team A, Day Shift, Thickness = 3.1
- Team B, Night Shift, Thickness = 3.9
- Team C, Day Shift, Thickness = 3.0

In all three cases, the defect rate in one of the measurements was above the upper control limit for the defect rate. The fact that measurements outside of the control limits were found does not immediately imply that these processes are out of control. Instead, these results consistute an indication that they should be further investigated. Design of Experiments should be performed in order to investigate the causes that led to the unusually high defect rates that were observed in these cases. For example, if some new technology was used in those processes, then that technology should be further evaluated in order to determine whether it was responsible for the abnormally high defect rates.

In any case, it should be noted that, in general, processes were found to be in control. None of the usual "out of control patterns" (except for the three outliers mentioned above) were found. This would suggest tha the company is generally doing well and does not require major changes.

ANOVA results thus suggested that all teams are performing equally well in terms of defect rates. Moreover, there are no significant differences in defect rates between the Day and Night Shift. The only significant result was that of Thickness. It was found that, as thickness increased, the defect rate increased as well. However, the relationship was somewhat weak.

Given that the relationship was weak, further experiments should be conducted in order to assess why it is that pieces with higher thickness were associated with higher defect rates.

The company might want to focus its attention on improving the processes for producing thicker pieces. If given the current technology level, the positive relationship between plate thickness and defect rate is to be expected, there is likely nothing the company can do in order to address these differences in defect rates. However, if there is no "fundamental" reason to get higher defect rates when producing piece with higher plate thickness, then the company should investigate the causes of this relationship. For example, it is possible that thicker pieces need a higher skill level on part of the workers, and thus the company might want to introduce training programs in order to equip its workers with better skills, thereby reducing the defect rates for thicker pieces.

References

American society for quality (n.d.) Retrieved December 1, 2007 from http://www.asq.org/learn-about-quality/data-collection-analysis-tools/overview/control-chart.html

Bauch, G. (2001, June). A statistical project control tool for engineering managers. *Project Management Journal*, *32*(2), 37. Retrieved December 15, 2007, from http://ezproxy.lib.uwstout.edu:2170/ehost/detail?vid=6&hid=12&sid=04c88156-8de0-4088-818f-6bda3086f9e9%40sessionmgr3. Business Source Elite database.

Forerest, W., Breyfogle III. (2003). *Implementing six sigma* (2nd ed., text rev.). Hobokoken, NJ.

James, R. Evans, J. R., & Lindsay, W. M. (2002). *The management and control of quality* (5th ed., text rev.). USA: West Group.

Leavenworth, G. (1988). *Statistical quality control* (6th ed., text rev.) USA: McGraw-Hill, Inc.

Six sigma (n.d.) Retrieved December 5, 2007 from http://search-www.isixsigma.com/cgi-bin/ss_queary?related=0&keys=control+chart&sitebr=130985463&pl=

Summers, D. C. S. (2006). *Quality* (4th ed., text rev.). NJ: Upper Saddle River.

Quality Control Chart. (n.d.). Retrieved November 28, 2007, from: http://sunsite.univie.ac.at/textbooks/statistics/stquacon.html#variables

Appendix A

Manufacturer's Data

Data obtained from XYZ company

Shift start	Shift	Team	Thk.	% Defect
2/1/2007 6:30	DAYS	B	3.1	0.48%
2/1/2007 6:30	DAYS	B	2.3	1.29%
2/1/2007 18:30	NIGHTS	A	2.3	1.82%
2/1/2007 18:30	NIGHTS	A	2.2	0.84%
2/1/2007 18:30	NIGHTS	A	3.1	1.10%
2/2/2007 6:30	DAYS	D	3.1	1.51%
2/2/2007 6:30	DAYS	D	3.9	2.30%
2/2/2007 18:30	NIGHTS	C	3.9	2.29%
2/3/2007 6:30	DAYS	D	5.7	1.37%
2/3/2007 18:30	NIGHTS	C	5.7	0.96%
2/3/2007 18:30	NIGHTS	C	5.8	4.88%
2/4/2007 6:30	DAYS	D	5.8	6.74%
2/4/2007 6:30	DAYS	D	4.7	0.75%
2/4/2007 18:30	NIGHTS	C	4.7	2.51%
2/4/2007 18:30	NIGHTS	C	4.0	1.94%
2/4/2007 18:30	NIGHTS	C	3.1	1.67%
2/5/2007 6:30	DAYS	A	3.1	1.11%
2/5/2007 6:30	DAYS	A	2.3	2.23%
2/5/2007 18:30	NIGHTS	B	2.3	1.39%
2/5/2007 18:30	NIGHTS	B	2.2	0.67%
2/6/2007 6:30	DAYS	A	2.2	1.99%
2/6/2007 6:30	DAYS	A	3.0	1.75%
2/6/2007 18:30	NIGHTS	B	3.0	0.96%
2/7/2007 6:30	DAYS	C	3.0	1.06%
2/7/2007 6:30	DAYS	C	3.9	3.92%
2/7/2007 18:30	NIGHTS	D	3.9	2.90%
2/7/2007 18:30	NIGHTS	D	3.1	2.12%
2/8/2007 6:30	DAYS	C	3.1	2.29%
2/8/2007 6:30	DAYS	C	2.3	2.36%
2/8/2007 18:30	NIGHTS	D	2.3	2.89%
2/8/2007 18:30	NIGHTS	D	3.1	2.28%
2/9/2007 6:30	DAYS	B	3.1	3.03%
2/9/2007 18:30	NIGHTS	A	3.1	2.08%
2/9/2007 18:30	NIGHTS	A	3.9	1.81%
2/10/2007 6:30	DAYS	B	3.9	2.36%
2/10/2007 6:30	DAYS	B	4.0	1.05%
2/10/2007 18:30	NIGHTS	A	4.0	0.84%
2/10/2007 18:30	NIGHTS	A	3.1	2.13%
2/11/2007 6:30	DAYS	B	3.1	1.11%
2/11/2007 18:30	NIGHTS	A	3.1	1.54%
2/12/2007 6:30	DAYS	D	3.1	0.80%
2/12/2007 6:30	DAYS	D	2.3	3.33%

2/12/2007 6:30	DAYS	D	2.2	1.38%
2/12/2007 18:30	NIGHTS	C	2.2	0.42%
2/13/2007 6:30	DAYS	D	2.2	0.31%
2/13/2007 6:30	DAYS	D	3.0	0.87%
2/13/2007 18:30	NIGHTS	C	3.0	1.70%
2/13/2007 18:30	NIGHTS	C	3.9	4.43%
2/14/2007 6:30	DAYS	A	3.9	3.29%
2/14/2007 6:30	DAYS	A	3.1	4.94%
2/14/2007 18:30	NIGHTS	B	3.1	3.47%
2/15/2007 6:30	DAYS	A	3.1	3.19%
2/15/2007 6:30	DAYS	A	2.3	2.93%
2/15/2007 18:30	NIGHTS	B	2.3	2.92%
2/15/2007 18:30	NIGHTS	B	3.1	1.59%
2/16/2007 6:30	DAYS	C	3.1	2.72%
2/16/2007 6:30	DAYS	C	3.9	2.33%
2/16/2007 18:30	NIGHTS	D	3.9	1.11%
2/16/2007 18:30	NIGHTS	D	5.7	7.09%
2/17/2007 6:30	DAYS	C	5.7	1.88%
2/17/2007 6:30	DAYS	C	5.8	2.34%
2/17/2007 18:30	NIGHTS	D	5.8	1.27%
2/17/2007 18:30	NIGHTS	D	4.7	0.68%
2/18/2007 6:30	DAYS	C	4.7	0.73%
2/18/2007 18:30	NIGHTS	D	4.7	2.42%
2/18/2007 18:30	NIGHTS	D	4.0	0.32%
2/18/2007 18:30	NIGHTS	D	3.1	1.29%
2/19/2007 6:30	DAYS	B	3.1	1.82%
2/19/2007 6:30	DAYS	B	2.3	2.91%
2/19/2007 18:30	NIGHTS	A	2.3	2.71%
2/19/2007 18:30	NIGHTS	A	2.2	0.70%
2/20/2007 6:30	DAYS	B	2.2	6.00%
2/20/2007 6:30	DAYS	B	3.0	1.04%
2/20/2007 18:30	NIGHTS	A	3.0	0.63%
2/21/2007 6:30	DAYS	D	3.0	1.03%
2/21/2007 6:30	DAYS	D	3.9	2.49%
2/21/2007 18:30	NIGHTS	C	3.9	2.79%
2/21/2007 18:30	NIGHTS	C	3.1	1.88%
2/22/2007 6:30	DAYS	D	3.1	1.55%
2/22/2007 6:30	DAYS	D	2.3	2.04%
2/22/2007 18:30	NIGHTS	C	2.3	1.03%
2/22/2007 18:30	NIGHTS	C	3.1	1.72%
2/23/2007 6:30	DAYS	A	3.1	1.25%
2/23/2007 6:30	DAYS	A	3.9	1.61%
2/23/2007 18:30	NIGHTS	B	3.9	1.18%
2/24/2007 6:30	DAYS	A	3.9	0.78%
2/24/2007 6:30	DAYS	A	3.1	1.01%
2/24/2007 18:30	NIGHTS	B	3.1	1.28%
2/25/2007 6:30	DAYS	A	3.1	1.59%

2/25/2007 6:30	DAYS	A	3.0	0.42%
2/25/2007 18:30	NIGHTS	B	3.0	0.61%
2/26/2007 6:30	DAYS	C	3.0	0.86%
2/26/2007 6:30	DAYS	C	4.0	0.27%
2/26/2007 18:30	NIGHTS	D	4.0	0.91%
2/26/2007 18:30	NIGHTS	D	5.7	1.46%
2/26/2007 18:30	NIGHTS	D	5.8	3.21%
2/27/2007 6:30	DAYS	C	5.7	0.86%
2/27/2007 6:30	DAYS	C	5.8	0.83%
2/27/2007 18:30	DAYS	C	4.7	1.63%
2/27/2007 18:30	NIGHTS	D	4.7	2.17%
2/27/2007 18:30	NIGHTS	D	3.9	0.40%
2/28/2007 6:30	DAYS	B	3.9	1.09%
2/28/2007 6:30	DAYS	B	3.1	1.27%
2/28/2007 18:30	NIGHTS	A	3.1	0.94%
1/1/2007 6:30	DAYS	C	3.1	1.13%
1/1/2007 6:30	DAYS	C	3.0	1.09%
1/1/2007 18:30	NIGHTS	D	3.0	0.63%
1/2/2007 6:30	DAYS	C	3.0	0.52%
1/2/2007 6:30	DAYS	C	2.2	0.79%
1/2/2007 18:30	NIGHTS	D	2.2	0.57%
1/3/2007 6:30	DAYS	B	2.2	0.44%
1/3/2007 6:30	DAYS	B	2.3	1.87%
1/3/2007 18:30	NIGHTS	A	2.3	2.94%
1/3/2007 18:30	NIGHTS	A	3.1	1.24%
1/4/2007 6:30	DAYS	B	3.1	1.55%
1/4/2007 6:30	DAYS	B	3.9	1.66%
1/4/2007 18:30	NIGHTS	A	3.9	1.62%
1/5/2007 6:30	DAYS	D	4.0	1.68%
1/5/2007 6:30	DAYS	D	5.7	1.37%
1/5/2007 18:30	NIGHTS	C	5.7	2.00%
1/5/2007 18:30	NIGHTS	C	4.7	1.20%
1/6/2007 6:30	DAYS	D	4.7	2.76%
1/6/2007 6:30	DAYS	D	3.9	1.17%
1/6/2007 18:30	NIGHTS	C	3.9	1.68%
1/6/2007 18:30	NIGHTS	C	3.1	1.95%
1/7/2007 6:30	DAYS	D	3.1	1.60%
1/7/2007 18:30	NIGHTS	C	3.1	1.00%
1/8/2007 6:30	DAYS	A	3.1	1.89%
1/8/2007 6:30	DAYS	A	2.3	1.74%
1/8/2007 18:30	NIGHTS	B	2.3	1.64%
1/8/2007 18:30	NIGHTS	B	2.2	0.73%
1/9/2007 6:30	DAYS	A	2.2	1.08%
1/9/2007 6:30	DAYS	A	3.0	1.17%
1/9/2007 18:30	NIGHTS	B	3.0	0.91%
1/9/2007 18:30	NIGHTS	B	3.1	1.34%
1/10/2007 6:30	DAYS	C	3.1	0.00%

1/10/2007 6:30	DAYS	C	3.9	1.72%
1/10/2007 18:30	NIGHTS	D	3.1	3.29%
1/11/2007 6:30	DAYS	C	3.1	1.77%
1/11/2007 6:30	DAYS	C	2.3	1.57%
1/11/2007 18:30	NIGHTS	D	2.3	1.98%
1/11/2007 18:30	NIGHTS	D	3.1	2.45%
1/12/2007 6:30	DAYS	B	3.1	2.97%
1/12/2007 6:30	DAYS	B	4.0	0.54%
1/12/2007 18:30	NIGHTS	A	4.0	0.55%
1/12/2007 18:30	NIGHTS	A	5.7	4.12%
1/13/2007 6:30	DAYS	B	5.7	7.28%
1/13/2007 6:30	DAYS	B	4.7	2.04%
1/13/2007 18:30	NIGHTS	A	4.7	3.85%
1/13/2007 18:30	NIGHTS	A	3.9	1.98%
1/14/2007 6:30	DAYS	B	3.9	3.14%
1/14/2007 6:30	DAYS	B	3.1	3.28%
1/14/2007 18:30	NIGHTS	A	3.1	2.26%
1/15/2007 6:30	DAYS	D	3.1	3.27%
1/15/2007 6:30	DAYS	D	2.3	2.03%
1/15/2007 18:30	NIGHTS	C	2.3	1.50%
1/15/2007 18:30	NIGHTS	C	2.2	0.41%
1/16/2007 6:30	DAYS	D	2.2	1.57%
1/16/2007 6:30	DAYS	D	3.0	0.71%
1/16/2007 18:30	NIGHTS	C	3.0	0.80%
1/16/2007 18:30	NIGHTS	C	3.9	1.88%
1/16/2007 18:30	NIGHTS	C	3.1	1.11%
1/17/2007 6:30	DAYS	A	3.1	2.79%
1/17/2007 18:30	NIGHTS	B	3.1	2.13%
1/18/2007 6:30	DAYS	A	3.1	4.02%
1/18/2007 6:30	DAYS	A	2.3	2.01%
1/18/2007 18:30	NIGHTS	B	2.3	2.18%
1/18/2007 18:30	NIGHTS	B	3.1	1.61%
1/19/2007 6:30	DAYS	C	3.1	2.41%
1/19/2007 6:30	DAYS	C	3.9	3.72%
1/19/2007 18:30	NIGHTS	D	3.9	2.11%
1/20/2007 6:30	DAYS	C	3.9	1.67%
1/20/2007 6:30	DAYS	C	4.0	8.00%
1/20/2007 18:30	NIGHTS	D	4.0	0.42%
1/20/2007 18:30	NIGHTS	D	3.1	1.84%
1/21/2007 6:30	DAYS	C	3.1	1.54%
1/21/2007 18:30	NIGHTS	D	3.1	1.59%
1/22/2007 6:30	DAYS	B	3.1	2.08%
1/22/2007 6:30	DAYS	B	2.3	2.02%
1/22/2007 18:30	NIGHTS	A	2.3	2.52%
1/22/2007 18:30	NIGHTS	A	2.2	0.63%
1/23/2007 6:30	DAYS	B	2.2	0.54%
1/23/2007 6:30	DAYS	B	3.0	1.53%

1/23/2007 18:30	NIGHTS	A	3.0	0.91%
1/24/2007 6:30	DAYS	D	3.0	1.30%
1/24/2007 6:30	DAYS	D	3.9	1.19%
1/24/2007 6:30	DAYS	D	3.1	1.64%
1/24/2007 18:30	NIGHTS	C	3.1	1.18%
1/25/2007 6:30	DAYS	D	3.1	1.12%
1/25/2007 6:30	DAYS	D	2.3	2.43%
1/25/2007 18:30	NIGHTS	C	2.3	1.51%
1/25/2007 18:30	NIGHTS	C	3.1	1.73%
1/26/2007 6:30	DAYS	A	3.1	2.25%
1/26/2007 6:30	DAYS	A	3.9	3.10%
1/26/2007 18:30	NIGHTS	B	3.9	4.92%
1/26/2007 18:30	NIGHTS	B	5.7	1.83%
1/27/2007 6:30	DAYS	A	5.7	0.76%
1/27/2007 6:30	DAYS	A	4.7	1.64%
1/27/2007 18:30	NIGHTS	B	4.7	4.04%
1/27/2007 18:30	NIGHTS	B	4.0	1.04%
1/28/2007 6:30	DAYS	A	4.0	1.34%
1/28/2007 6:30	DAYS	A	3.1	1.38%
1/28/2007 18:30	NIGHTS	B	3.1	2.88%
1/28/2007 18:30	NIGHTS	B	2.7	2.60%
1/29/2007 6:30	DAYS	C	2.7	1.51%
1/29/2007 6:30	DAYS	C	2.3	2.61%
1/29/2007 6:30	DAYS	C	2.2	0.89%
1/29/2007 18:30	NIGHTS	D	2.2	0.46%
1/30/2007 6:30	DAYS	C	2.2	0.91%
1/30/2007 6:30	DAYS	C	3.0	5.00%
1/30/2007 18:30	NIGHTS	D	3.0	0.32%
1/30/2007 18:30	NIGHTS	D	3.9	0.41%
1/31/2007 6:30	DAYS	B	3.9	0.64%
1/31/2007 6:30	DAYS	B	3.1	1.40%
1/31/2007 18:30	NIGHTS	A	3.1	0.95%
12/1/2006 7:00	DAYS	A	3.1	2.34%
12/1/2006 7:00	DAYS	A	3.9	1.80%
12/1/2006 19:00	NIGHTS	B	3.9	1.52%
12/1/2006 19:00	NIGHTS	B	5.7	1.56%
12/2/2006 7:00	DAYS	A	5.7	1.22%
12/2/2006 19:00	NIGHTS	B	4.7	0.91%
12/3/2006 7:00	DAYS	A	4.7	2.38%
12/3/2006 7:00	DAYS	A	4.0	0.49%
12/3/2006 7:00	DAYS	A	3.1	1.46%
12/3/2006 19:00	NIGHTS	B	3.1	0.86%
12/4/2006 7:00	DAYS	C	3.1	1.65%
12/4/2006 7:00	DAYS	C	2.7	3.04%
12/4/2006 19:00	NIGHTS	D	2.2	0.73%
12/5/2006 7:00	DAYS	C	2.2	1.21%
12/5/2006 7:00	DAYS	C	3.0	1.25%

12/5/2006 19:00	NIGHTS	D	3.0	1.73%
12/6/2006 7:00	DAYS	B	3.9	2.90%
12/6/2006 19:00	NIGHTS	A	3.1	1.82%
12/7/2006 7:00	DAYS	B	3.1	1.67%
12/7/2006 7:00	DAYS	B	2.3	1.58%
12/7/2006 19:00	NIGHTS	A	2.3	1.41%
12/7/2006 19:00	NIGHTS	A	3.1	1.33%
12/8/2006 7:00	DAYS	D	3.1	1.46%
12/8/2006 7:00	DAYS	D	3.9	1.70%
12/8/2006 19:00	NIGHTS	C	3.9	1.45%
12/8/2006 19:00	NIGHTS	C	4.7	1.59%
12/9/2006 7:00	DAYS	D	4.7	0.72%
12/9/2006 7:00	DAYS	D	4.0	0.63%
12/9/2006 19:00	NIGHTS	C	4.0	0.32%
12/9/2006 19:00	NIGHTS	C	3.9	1.01%
12/10/2006 7:00	DAYS	D	3.9	1.91%
12/10/2006 7:00	DAYS	D	3.1	2.19%
12/10/2006 19:00	NIGHTS	C	3.1	1.40%
12/11/2006 7:00	DAYS	A	3.1	1.26%
12/11/2006 7:00	DAYS	A	2.3	1.34%
12/11/2006 19:00	NIGHTS	B	2.2	0.83%
12/12/2006 7:00	DAYS	A	2.2	0.97%
12/12/2006 7:00	DAYS	A	3.0	0.97%
12/12/2006 19:00	NIGHTS	B	3.0	0.85%
12/12/2006 19:00	NIGHTS	B	3.9	2.39%
12/13/2006 7:00	DAYS	C	3.9	2.19%
12/13/2006 7:00	DAYS	C	3.1	2.14%
12/13/2006 19:00	NIGHTS	D	3.1	1.79%
12/14/2006 7:00	DAYS	C	3.1	7.10%
12/14/2006 7:00	DAYS	C	2.3	1.66%
12/14/2006 19:00	NIGHTS	D	2.3	2.73%
12/14/2006 19:00	NIGHTS	D	3.1	1.35%
12/15/2006 7:00	DAYS	B	3.1	1.80%
12/15/2006 7:00	DAYS	B	3.9	1.75%
12/15/2006 19:00	NIGHTS	A	3.9	1.50%
12/15/2006 19:00	NIGHTS	A	5.7	1.35%
12/16/2006 7:00	DAYS	B	5.7	1.42%
12/16/2006 7:00	DAYS	B	4.7	3.60%
12/16/2006 19:00	NIGHTS	A	4.7	3.56%
12/16/2006 19:00	NIGHTS	A	4.0	0.87%
12/17/2006 7:00	DAYS	B	4.0	0.56%
12/17/2006 7:00	DAYS	B	3.1	3.89%
12/17/2006 19:00	NIGHTS	A	3.1	1.12%
12/18/2006 7:00	DAYS	D	3.1	2.23%
12/18/2006 7:00	DAYS	D	2.3	2.26%
12/18/2006 19:00	NIGHTS	C	2.3	3.00%
12/18/2006 19:00	NIGHTS	C	2.2	0.97%

12/19/2006 7:00	DAYS	D	2.2	0.78%
12/19/2006 7:00	DAYS	D	3.0	0.79%
12/19/2006 19:00	NIGHTS	C	3.0	0.94%
12/20/2006 7:00	DAYS	A	3.0	2.04%
12/20/2006 7:00	DAYS	A	3.9	3.97%
12/20/2006 19:00	NIGHTS	B	3.9	6.16%
12/20/2006 19:00	NIGHTS	B	3.1	3.15%
12/21/2006 7:00	DAYS	A	3.1	2.08%
12/21/2006 7:00	DAYS	A	2.3	2.28%
12/21/2006 19:00	NIGHTS	B	2.3	2.17%
12/21/2006 19:00	NIGHTS	B	3.1	2.65%
12/22/2006 7:00	DAYS	C	3.1	2.12%
12/22/2006 19:00	NIGHTS	D	3.1	0.79%
12/22/2006 19:00	NIGHTS	D	3.9	0.35%
12/23/2006 7:00	DAYS	C	3.9	1.24%
12/23/2006 19:00	NIGHTS	D	3.9	0.71%
12/23/2006 19:00	NIGHTS	D	4.7	0.91%
12/24/2006 7:00	DAYS	C	4.7	2.60%
12/24/2006 7:00	DAYS	C	4.0	0.88%
12/24/2006 7:00	DAYS	C	3.1	1.11%
12/24/2006 19:00	NIGHTS	D	3.1	1.59%
12/25/2006 7:00	DAYS	B	3.1	1.46%
12/25/2006 19:00	NIGHTS	A	3.1	1.61%
12/25/2006 19:00	NIGHTS	A	2.7	2.78%
12/26/2006 7:00	DAYS	B	2.7	0.89%
12/26/2006 7:00	DAYS	B	2.3	1.30%
12/26/2006 19:00	NIGHTS	A	2.3	1.98%
12/26/2006 19:00	NIGHTS	A	2.2	0.46%
12/27/2006 7:00	DAYS	D	2.2	0.84%
12/27/2006 7:00	DAYS	D	3.0	0.37%
12/27/2006 19:00	NIGHTS	C	3.0	0.58%
12/28/2006 7:00	DAYS	D	3.0	0.64%
12/28/2006 7:00	DAYS	D	3.9	0.42%
12/28/2006 19:00	NIGHTS	C	3.9	2.38%
12/28/2006 19:00	NIGHTS	C	3.1	1.34%
12/29/2006 7:00	DAYS	A	3.1	1.69%
12/29/2006 19:00	NIGHTS	B	3.1	1.53%
12/30/2006 7:00	DAYS	A	3.1	2.32%
12/30/2006 7:00	DAYS	A	3.9	0.68%
12/30/2006 19:00	NIGHTS	B	3.9	1.11%
12/30/2006 19:00	NIGHTS	B	3.1	1.19%
12/31/2006 7:00	DAYS	A	3.1	2.16%
12/31/2006 19:00	NIGHTS	B	3.1	0.99%

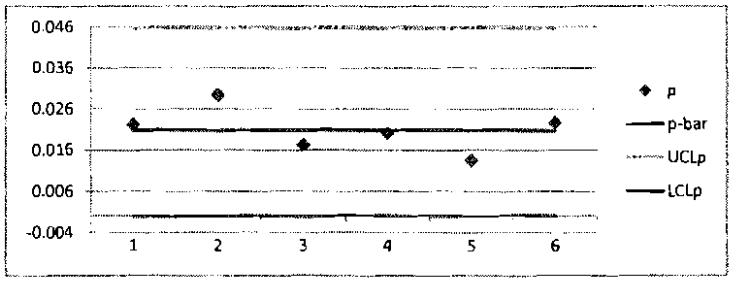
S. No	Shift start	shift	Team	Thk.	% Defect	n	np	p	p-bar
1	2/5/2007 6:30	DAYS	A	2.3	2.23%	300	6.69	0.0223	0.020883
2	2/15/2007 6:30	DAYS	A	2.3	2.93%	300	8.79	0.0293	0.020883
3	1/8/2007 6:30	DAYS	A	2.3	1.74%	300	5.22	0.0174	0.020883
4	1/18/2007 6:30	DAYS	A	2.3	2.01%	300	6.03	0.0201	0.020883
5	12/11/2006 7:00	DAYS	A	2.3	1.34%	300	4.02	0.0134	0.020883
6	12/21/2006 7:00	DAYS	A	2.3	2.28%	300	6.84	0.0228	0.020883
						∑np =	37.59		

S. No.	Shift start	shift	Team	Thk.	% Defect	n	np	p	p-bar
1	2/6/2007 6:30	DAYS	A	3.0	1.75%	300	5.25	0.0175	0.0127
2	2/25/2007 6:30	DAYS	A	3.0	0.42%	300	1.26	0.0042	0.0127
3	1/9/2007 6:30	DAYS	A	3.0	1.17%	300	3.51	0.0117	0.0127
4	12/12/2006 7:00	DAYS	A	3.0	0.97%	300	2.91	0.0097	0.0127
5	12/20/2006 7:00	DAYS	A	3.0	2.04%	300	6.12	0.0204	0.0127
						∑np =	19.05		

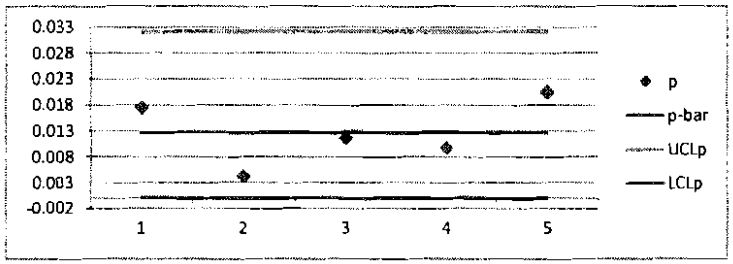
S. No.	Shift start	shift	Team	Thk.	% Defect	n	np	p	p-bar
1	2/5/2007 6:30	DAYS	A	3.1	1.11%	300	3.33	0.0111	0.021517
2	2/14/2007 6:30	DAYS	A	3.1	4.94%	300	14.82	0.0494	0.021517
3	2/15/2007 6:30	DAYS	A	3.1	3.19%	300	9.57	0.0319	0.021517
4	2/23/2007 6:30	DAYS	A	3.1	1.25%	300	3.75	0.0125	0.021517
5	2/24/2007 6:30	DAYS	A	3.1	1.01%	300	3.03	0.0101	0.021517
6	2/25/2007 6:30	DAYS	A	3.1	1.59%	300	4.77	0.0159	0.021517
7	1/8/2007 6:30	DAYS	A	3.1	1.89%	300	5.67	0.0189	0.021517
8	1/17/2007 6:30	DAYS	A	3.1	2.79%	300	8.37	0.0279	0.021517
9	1/18/2007 6:30	DAYS	A	3.1	4.02%	300	12.06	0.0402	0.021517
10	1/26/2007 6:30	DAYS	A	3.1	2.25%	300	6.75	0.0225	0.021517
11	1/28/2007 6:30	DAYS	A	3.1	1.38%	300	4.14	0.0138	0.021517
12	12/1/2006 7:00	DAYS	A	3.1	2.34%	300	7.02	0.0234	0.021517
13	12/3/2006 7:00	DAYS	A	3.1	1.46%	300	4.38	0.0146	0.021517
14	12/11/2006 7:00	DAYS	A	3.1	1.26%	300	3.78	0.0126	0.021517
15	12/21/2006 7:00	DAYS	A	3.1	2.08%	300	6.24	0.0208	0.021517
16	12/29/2006 7:00	DAYS	A	3.1	1.69%	300	5.07	0.0169	0.021517
17	12/30/2006 7:00	DAYS	A	3.1	2.32%	300	6.96	0.0232	0.021517
18	12/31/2006 7:00	DAYS	A	3.1	2.16%	300	6.48	0.0216	0.021517
						∑np =	116.19		

S. No.	Shift start	shift	Team	Thk.	% Defect	n	np	p	p-bar
1	2/14/2007 6:30	DAYS	A	3.9	3.29%	300	9.87	0.0329	0.021757
2	2/23/2007 6:30	DAYS	A	3.9	1.61%	300	4.83	0.0161	0.021757
3	2/24/2007 6:30	DAYS	A	3.9	0.78%	300	2.34	0.0078	0.021757
4	1/26/2007 6:30	DAYS	A	3.9	3.10%	300	9.3	0.031	0.021757
5	12/1/2006 7:00	DAYS	A	3.9	1.80%	300	5.4	0.018	0.021757
6	12/20/2006 7:00	DAYS	A	3.9	3.97%	300	11.91	0.0397	0.021757
7	12/30/2006 7:00	DAYS	A	3.9	0.68%	300	2.04	0.0068	0.021757
						∑np =	45.69		

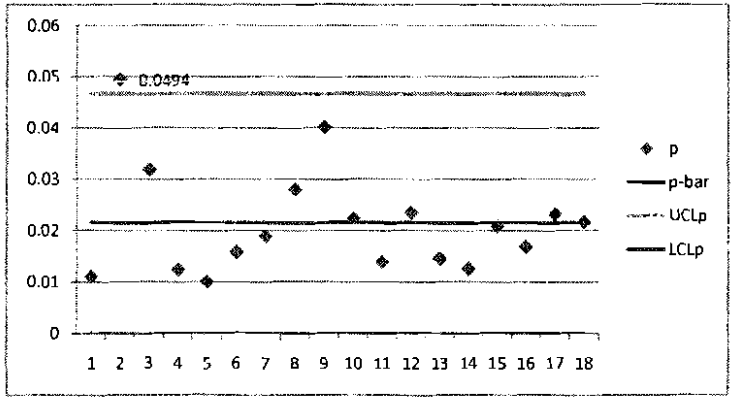
UCLp	LCLp
0.045651	0
0.045651	0
0.045651	0
0.045651	0
0.045651	0
0.045651	0



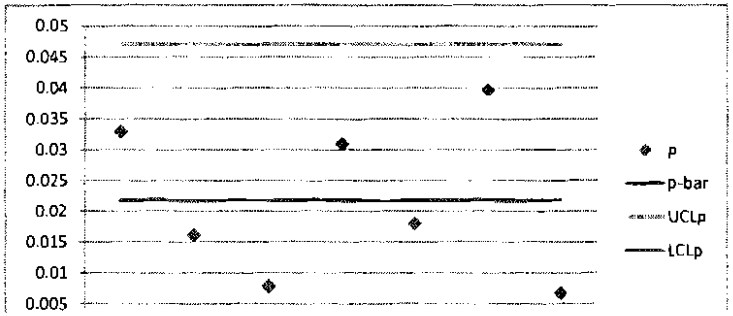
UCLp	LCLp
0.032095	0
0.032095	0
0.032095	0
0.032095	0
0.032095	0



UCLp	LCLp
0.046649	0
0.046649	0
0.046649	0
0.046649	0
0.046649	0
0.046649	0
0.046649	0
0.046649	0
0.046649	0
0.046649	0
0.046649	0
0.046649	0
0.046649	0
0.046649	0
0.046649	0
0.046649	0
0.046649	0



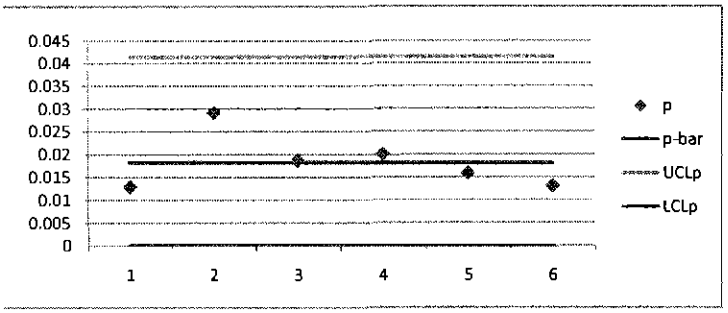
UCLp	LCLp
0.047026	0
0.047026	0
0.047026	0
0.047026	0
0.047026	0
0.047026	0
0.047026	0

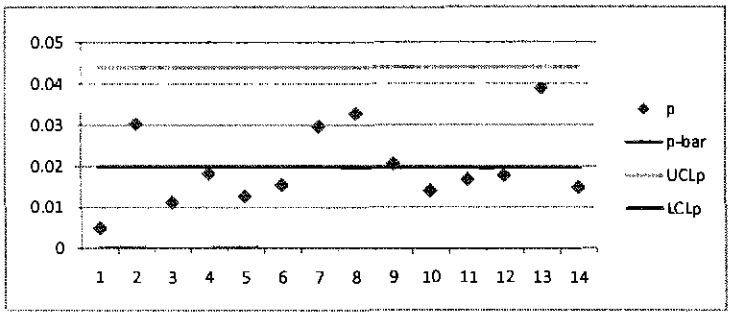


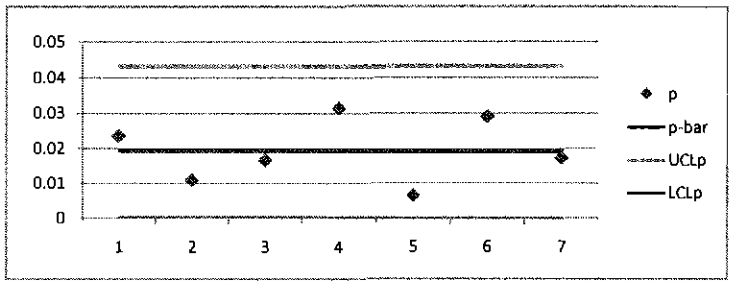
S No.	Shift start	shift	Team	Thk.	% Defect	n	np	p	p-bar	UCLp	LCLp
1	2/1/2007 6.30	DAYS	B	2 3	1.29%	300	3.87	0.0129	0.018283	0.041488	0
2	2/19/2007 6:30	DAYS	B	2.3	2.91%	300	8.73	0 0291	0.018283	0.041488	0
3	1/3/2007 6:30	DAYS	B	2.3	1.87%	300	5.61	0.0187	0.018283	0.041488	0
4	1/22/2007 6:30	DAYS	B	2.3	2.02%	300	6.06	0.0202	0.018283	0.041488	0
5	12/7/2006 7.00	DAYS	B	2.3	1.58%	300	4.74	0.0158	0.018283	0.041488	0
6	12/26/2006 7:00	DAYS	B	2.3	1.30%	300	3.9	0.013	0.018283	0.041488	0
						∑np =	32.91				

S. No.	Shift start	shift	Team	Thk.	% Defect	n	np	p	p-bar	UCLp	LCLp
1	2/1/2007 6:30	DAYS	B	3.1	0.48%	300	1.44	0.0048	0.019864	0.044032	0
2	2/9/2007 6:30	DAYS	B	3.1	3.03%	300	9.09	0.0303	0.019864	0.044032	0
3	2/11/2007 6:30	DAYS	B	3.1	1.11%	300	3.33	0.0111	0.019864	0.044032	0
4	2/19/2007 6:30	DAYS	B	3.1	1.82%	300	5.46	0.0182	0.019864	0.044032	0
5	2/28/2007 6:30	DAYS	B	3 1	1.27%	300	3.81	0.0127	0.019864	0.044032	0
6	1/4/2007 6:30	DAYS	B	3.1	1.55%	300	4.65	0.0155	0.019864	0.044032	0
7	1/12/2007 6:30	DAYS	B	3.1	2.97%	300	8.91	0.0297	0.019864	0.044032	0
8	1/14/2007 6:30	DAYS	B	3 1	3.28%	300	9.84	0.0328	0.019864	0.044032	0
9	1/22/2007 6.30	DAYS	B	3.1	2.08%	300	6.24	0.0208	0.019864	0.044032	0
10	1/31/2007 6:30	DAYS	B	3.1	1.40%	300	4.2	0.014	0.019864	0.044032	0
11	12/7/2006 7:00	DAYS	B	3.1	1.67%	300	5.01	0.0167	0.019864	0.044032	0
12	12/15/2006 7:00	DAYS	B	3.1	1.80%	300	5.4	0.018	0.019864	0.044032	0
13	12/17/2006 7:00	DAYS	B	3.1	3 89%	300	11.67	0.0389	0 019864	0.044032	0
14	12/25/2006 7:00	DAYS	B	3.1	1.46%	300	4.38	0.0146	0.019864	0.044032	0
						∑np =	83.43				

S. No.	Shift start	shift	Team	Thk.	% Defect	n	np	p	p-bar	UCLp	LCLp
1	2/10/2007 6:30	DAYS	B	3.9	2.36%	300	7.08	0.0236	0.019343	0.043198	0
2	2/28/2007 6:30	DAYS	B	3.9	1.09%	300	3.27	0.0109	0.019343	0.043198	0
3	1/4/2007 6:30	DAYS	B	3.9	1.66%	300	4.98	0.0166	0.019343	0.043198	0
4	1/14/2007 6:30	DAYS	B	3.8	3.14%	300	9.42	0.0314	0.019343	0.043198	0
5	1/31/2007 6:30	DAYS	B	3.9	0.64%	300	1.92	0.0064	0.019343	0.043198	0
6	12/6/2006 7:00	DAYS	B	3.9	2.90%	300	8.7	0.029	0.019343	0.043198	0
7	12/15/2006 7:00	DAYS	B	3.9	1 75%	300	5.25	0 0175	0.019343	0.043198	0
						∑np =	40.62				


0.045
0.04
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0
1
2
3
4
5
6
p
p-bar
UCLp
LCLp


0.05
0.04
0.03
0.02
0.01
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
p
p-bar
UCLp
LCLp


0.05
0.04
0.03
0.02
0.01
0
1
2
3
4
5
6
7
p
p-bar
UCLp
LCLp

S. No	Shift start	shift	Team	Thk	% Defect	n	np	p	p-bar	UCLp
1	1/2/2007 6:30	DAYS	C	2.2	0.79%	300	2.37	0.0079	0.0095	0.026302
2	1/29/2007 6:30	DAYS	C	2.2	0 89%	300	2.67	0 0089	0.0095	0.026302
3	1/30/2007 6:30	DAYS	C	2.2	0.91%	300	2.73	0.0091	0.0095	0.026302
4	12/5/2006 7:00	DAYS	C	2.2	1 21%	300	3.63	0.0121	0.0095	0.026302
						∑np =	11.4			

S. No.	Shift start	shift	Team	Thk.	% Defect	n	np	p	p-bar	UCLp
1	2/8/2007 6:30	DAYS	C	2.3	2.36%	300	7.08	0 0236	0.02051	0.045054
2	1/11/2007 6:30	DAYS	C	2.3	1.57%	300	4.71814	0.01573	0.02051	0.045054
3	1/29/2007 6:30	DAYS	C	2 3	2.61%	300	7.83	0.0261	0.02051	0.045054
4	12/14/2006 7:00	DAYS	C	2.3	1.66%	300	4.98	0.0166	0.02051	0.045054
						∑np =	24.6081			

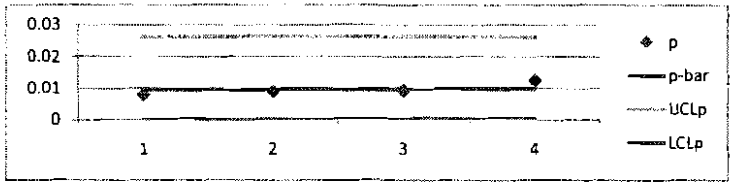
S. No.	Shift start	shift	Team	Thk.	% Defect	n	np	p	p-bar	UCLp
1	2/7/2007 6:30	DAYS	C	3.0	1.06%	300	3.18	0 0106	0.0163	0.038232
2	2/26/2007 6:30	DAYS	C	3.0	0.86%	300	2.58	0.0086	0.0163	0.038232
3	1/1/2007 6.30	DAYS	C	3.0	1.09%	300	3.27	0.0109	0.0163	0.038232
4	1/2/2007 6:30	DAYS	C	3.0	0.52%	300	1.56	0.0052	0.0163	0.038232
5	1/30/2007 6:30	DAYS	C	3.0	5.00%	300	15	0.05	0.0163	0.038232
6	12/5/2006 7:00	DAYS	C	3 0	1.25%	300	3.75	0.0125	0.0163	0.038232
						∑np =	29.34			

S No.	Shift start	shift	Team	Thk.	% Defect	n	np	p	p-bar	UCLp
1	2/8/2007 6:30	DAYS	C	3.1	2.29%	300	6.87	0.0229	0.02365	0.049965
2	2/16/2007 6:30	DAYS	C	3.1	2.72%	300	8.16	0.0272	0.02365	0.049965
3	1/1/2007 6:30	DAYS	C	3.1	1.13%	300	3.39	0.0113	0.02365	0.049965
4	1/10/2007 6:30	DAYS	C	3 1	0 00%	300	0	0	0.02365	0.049965
5	1/11/2007 6:30	DAYS	C	3.1	1.77%	300	5.3202	0.01773	0.02365	0.049965
6	1/19/2007 6:30	DAYS	C	3.1	2.41%	300	7.23	0.0241	0.02365	0.049965
7	1/21/2007 6:30	DAYS	C	3.1	1.54%	300	4.62	0 0154	0.02365	0.049965
8	12/4/2006 7 00	DAYS	C	3.1	1.65%	300	4.95	0.0165	0.02365	0.049965
9	12/13/2006 7.00	DAYS	C	3.1	2.14%	300	6.42	0.0214	0.02365	0.049965
10	12/14/2006 7:00	DAYS	C	3.1	7.10%	300	21.3	0.071	0.02365	0.049965
11	12/22/2006 7:00	DAYS	C	3.1	2.12%	300	6.36	0.0212	0.02365	0.049965
12	2/8/2007 6.30	DAYS	C	3.1	3.50%	300	10.5091	0.03503	0.02365	0.049965
						∑np =	85.1293			

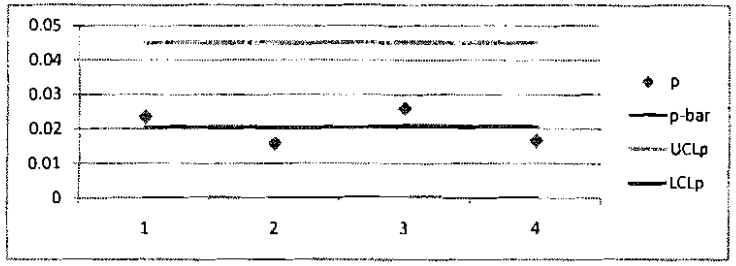
S. No	Shift start	shift	Team	Thk	% Defect	n	np	p	p-bar	UCLp
1	2/7/2007 6:30	DAYS	C	3.9	3.92%	300	11.76	0 0392	0.02399	0.050487
2	2/16/2007 6:30	DAYS	C	3 9	2 33%	300	6.99	0.0233	0.02399	0.050487
3	1/10/2007 6:30	DAYS	C	3 9	1.72%	300	5.16	0 0172	0.02399	0.050487
4	1/19/2007 6.30	DAYS	C	3.9	3.72%	300	11.16	0 0372	0.02399	0.050487
5	1/20/2007 6:30	DAYS	C	3.9	1.67%	300	5.01	0.0167	0.02399	0.050487

6	12/13/2006 7:00	DAYS	C	3.9	2.19%	300	6.57	0.0219	0.02399	0.050487
7	12/23/2006 7:00	DAYS	C	3.9	1.24%	300	3.72	0.0124	0.02399	0.050487
						∑np =	50.37			

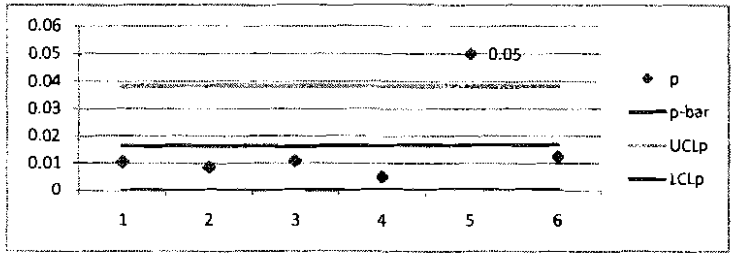
LCLp
0
0
0
0



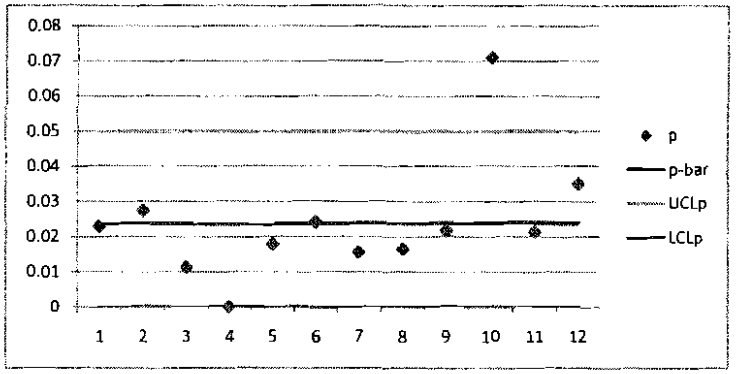
LCLp
0
0
0
0



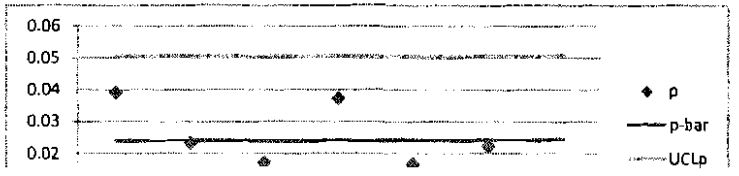
LCLp
0
0
0
0
0
0



LCLp
0
0
0
0
0
0
0
0
0
0

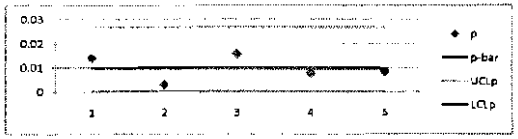


LCLp
0
0
0
0
0

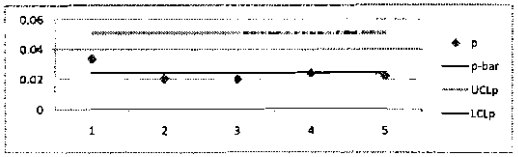



LCLp
0.01
0
1
2
3
4
5
6
7
0
0

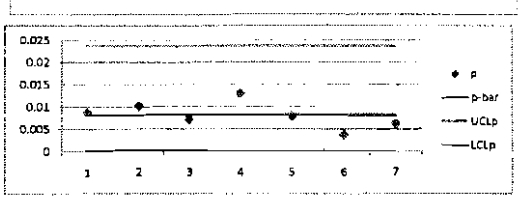
S. No	Shift start	shift	Team	Thk.	% Defect	n	np	p	p-bar	UCLp	LCLp	
1	2/12/2007 6:30	DAYS	D	2.2	1.38%	300	4.14	0.0138	0.00976	0.026788		0
2	2/13/2007 6:30	DAYS	D	2.2	0.31%	300	0.93	0.0031	0.00976	0.026788		0
3	1/16/2007 6:30	DAYS	D	2.2	1.57%	300	4.71	0.0157	0.00976	0.026788		0
4	12/19/2006 7:00	DAYS	D	2.2	0.78%	300	2.34	0.0078	0.00976	0.026788		0
5	12/27/2006 7:00	DAYS	D	2.2	0.84%	300	2.52	0.0084	0.00976	0.026788		0
						∑np =	14.64					



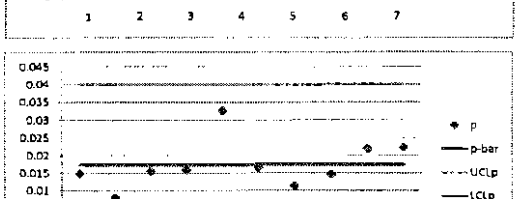
S. No	Shift start	shift	Team	Thk.	% Defect	n	np	p	p-bar	UCLp	LCLp	
1	2/12/2007 6:30	DAYS	D	2.3	3.33%	300	9.99	0.0333	0.02418	0.050786		0
2	2/22/2007 6:30	DAYS	D	2.3	2.04%	300	6.12	0.0204	0.02418	0.050786		0
3	1/15/2007 6:30	DAYS	D	2.3	2.03%	300	6.09	0.0203	0.02418	0.050786		0
4	1/25/2007 6:30	DAYS	D	2.3	2.43%	300	7.29	0.0243	0.02418	0.050786		0
5	12/18/2006 7:00	DAYS	D	2.3	2.26%	300	6.78	0.0226	0.02418	0.050786		0
						∑np =	36.27					



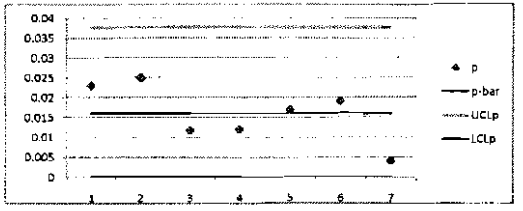
S. No	Shift start	shift	Team	Thk.	% Defect	n	np	p	p-bar	UCLp	LCLp	
1	2/13/2007 6:30	DAYS	D	3.0	0.87%	300	2.61	0.0087	0.008157	0.023737		0
2	2/21/2007 6:30	DAYS	D	3.0	1.03%	300	3.09	0.0103	0.008157	0.023737		0
3	1/16/2007 6:30	DAYS	D	3.0	0.71%	300	2.13	0.0071	0.008157	0.023737		0
4	1/24/2007 6:30	DAYS	D	3.0	1.30%	300	3.9	0.013	0.008157	0.023737		0
5	12/19/2006 7:00	DAYS	D	3.0	0.79%	300	2.37	0.0079	0.008157	0.023737		0
6	12/27/2006 7:00	DAYS	D	3.0	0.37%	300	1.11	0.0037	0.008157	0.023737		0
7	12/28/2006 7:00	DAYS	D	3.0	0.64%	300	1.92	0.0064	0.008157	0.023737		0
						∑np =	17.13					



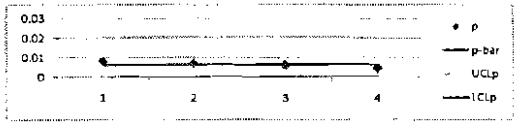
S. No.	Shift start	shift	Team	Thk	% Defect	n	np	p	p-bar	UCLp	LCLp	
1	2/2/2007 6:30	DAYS	D	3.1	1.51%	300	4.53	0.0151	0.01737	0.039998		0
2	2/12/2007 6:30	DAYS	D	3.1	0.80%	300	2.4	0.008	0.01737	0.039998		0
3	2/22/2007 6:30	DAYS	D	3.1	1.55%	300	4.65	0.0155	0.01737	0.039998		0
4	1/7/2007 6:30	DAYS	D	3.1	1.60%	300	4.8	0.016	0.01737	0.039998		0
5	1/15/2007 6:30	DAYS	D	3.1	3.27%	300	9.81	0.0327	0.01737	0.039998		0
6	1/24/2007 6:30	DAYS	D	3.1	1.64%	300	4.92	0.0164	0.01737	0.039998		0
7	1/25/2007 6:30	DAYS	D	3.1	1.12%	300	3.36	0.0112	0.01737	0.039998		0
8	12/8/2006 7:00	DAYS	D	3.1	1.46%	300	4.38	0.0146	0.01737	0.039998		0
9	12/10/2006 7:00	DAYS	D	3.1	2.19%	300	6.57	0.0219	0.01737	0.039998		0
10	12/18/2006 7:00	DAYS	D	3.1	2.23%	300	6.69	0.0223	0.01737	0.039998		0
						∑np =	52.11					



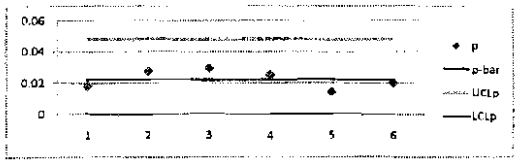
S. No	Shift start	shift	Team	Thk.	% Defect	n	np	p	p-bar	UCLp	LCLp	
1	2/2/2007 6:30	DAYS	D	3.9	2.30%	300	6.9	0.023	0.015971	0.037685		0
2	2/21/2007 6:30	DAYS	D	3.9	2.49%	300	7.47	0.0249	0.015971	0.037685		0
3	1/6/2007 6:30	DAYS	D	3.9	1.17%	300	3.51	0.0117	0.015971	0.037685		0
4	1/24/2007 6:30	DAYS	D	3.9	1.19%	300	3.57	0.0119	0.015971	0.037685		0
5	12/8/2006 7:00	DAYS	D	3.9	1.70%	300	5.1	0.017	0.015971	0.037685		0
6	12/10/2006 7:00	DAYS	D	3.9	1.91%	300	5.73	0.0191	0.015971	0.037685		0
7	12/28/2006 7:00	DAYS	D	3.9	0.42%	300	1.26	0.0042	0.015971	0.037685		0
						∑np =	33.54					



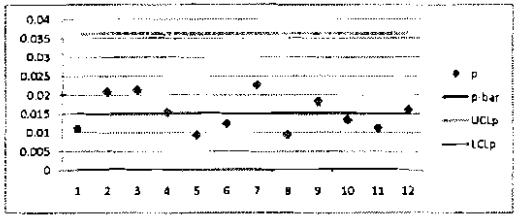
S. No	Shift start	shift	Team	Thk.	% Defect	n	np	p	p-bar	UCLp	LCLp
1	2/1/2007 18:30	NIGHTS	A	2.2	0.84%	300	2.52	0.0084	0.006575	0.020573	0
2	2/19/2007 18:30	NIGHTS	A	2.2	0.70%	300	2.1	0.007	0.006575	0.020573	0
3	1/22/2007 18:30	NIGHTS	A	2.2	0.63%	300	1.89	0.0063	0.006575	0.020573	0
4	12/26/2006 19:00	NIGHTS	A	2.2	0.46%	300	1.38	0.0046	0.006575	0.020573	0
						∑np =	7.89				



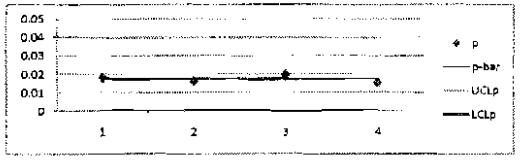
S. No	Shift start	shift	Team	Thk	% Defect	n	np	p	p-bar	UCLp	LCLp
1	2/1/2007 18:30	NIGHTS	A	2.3	1.82%	300	5.46	0.0182	0.0223	0.047875	0
2	2/19/2007 18:30	NIGHTS	A	2.3	2.71%	300	8.13	0.0271	0.0223	0.047875	0
3	1/3/2007 18:30	NIGHTS	A	2.3	2.94%	300	8.82	0.0294	0.0223	0.047875	0
4	1/22/2007 18:30	NIGHTS	A	2.3	2.52%	300	7.56	0.0252	0.0223	0.047875	0
5	12/7/2006 19:00	NIGHTS	A	2.3	1.41%	300	4.23	0.0141	0.0223	0.047875	0
6	12/26/2006 19:00	NIGHTS	A	2.3	1.98%	300	5.94	0.0198	0.0223	0.047875	0
						∑np =	40.14				



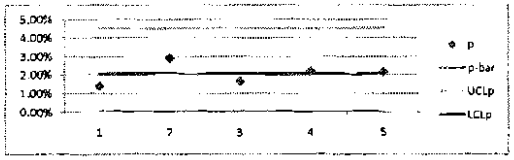
S. No.	Shift start	shift	Team	Thk	% Defect	n	np	p	p-bar	UCLp	LCLp
1	2/1/2007 18:30	NIGHTS	A	3.1	1.10%	300	3.3	0.011	0.0151	0.036222	0
2	2/9/2007 18:30	NIGHTS	A	3.1	2.08%	300	6.24	0.0208	0.0151	0.036222	0
3	2/10/2007 18:30	NIGHTS	A	3.1	2.13%	300	6.39	0.0213	0.0151	0.036222	0
4	2/11/2007 18:30	NIGHTS	A	3.1	1.54%	300	4.62	0.0154	0.0151	0.036222	0
5	2/28/2007 18:30	NIGHTS	A	3.1	0.94%	300	2.82	0.0094	0.0151	0.036222	0
6	1/3/2007 18:30	NIGHTS	A	3.1	1.24%	300	3.72	0.0124	0.0151	0.036222	0
7	1/14/2007 18:30	NIGHTS	A	3.1	2.26%	300	6.78	0.0226	0.0151	0.036222	0
8	1/31/2007 18:30	NIGHTS	A	3.1	0.95%	300	2.85	0.0095	0.0151	0.036222	0
9	12/6/2006 19:00	NIGHTS	A	3.1	1.82%	300	5.46	0.0182	0.0151	0.036222	0
10	12/7/2006 19:00	NIGHTS	A	3.1	1.33%	300	3.99	0.0133	0.0151	0.036222	0
11	12/17/2006 19:00	NIGHTS	A	3.1	1.12%	300	3.36	0.0112	0.0151	0.036222	0
12	12/25/2006 19:00	NIGHTS	A	3.1	1.61%	300	4.83	0.0161	0.0151	0.036222	0
						∑np =	54.36				



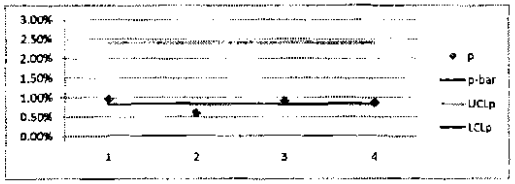
S. No.	Shift start	shift	Team	Thk	% Defect	n	np	p	p-bar	UCLp	LCLp
1	2/9/2007 18:30	NIGHTS	A	3.9	1.81%	300	5.43	0.0181	0.017275	0.039843	0
2	1/4/2007 18:30	NIGHTS	A	3.9	1.62%	300	4.86	0.0162	0.017275	0.039843	0
3	1/13/2007 18:30	NIGHTS	A	3.9	1.98%	300	5.94	0.0198	0.017275	0.039843	0
4	12/15/2006 19:00	NIGHTS	A	3.9	1.50%	300	4.5	0.015	0.017275	0.039843	0
						∑np =	20.73				



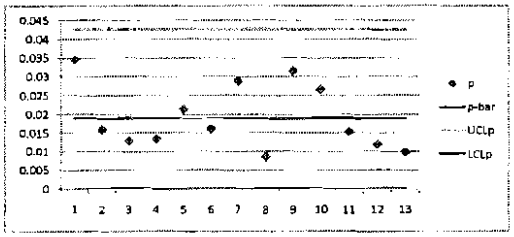
S. No	Shift start	shift	Team	Thk.	% Defect	n	np	p	p-bar	UCLp	LCLp
1	2/5/2007 18:30	NIGHTS	B	2.3	1.39%	300	4.17	1.39%	0.0206	0.045202	0
2	2/15/2007 18:30	NIGHTS	B	2.3	2.92%	300	8.76	2.92%	0.0206	0.045202	0
3	1/8/2007 18:30	NIGHTS	B	2.3	1.64%	300	4.92	1.64%	0.0206	0.045202	0
4	1/18/2007 18:30	NIGHTS	B	2.3	2.18%	300	6.54	2.18%	0.0206	0.045202	0
5	12/21/2006 19:00	NIGHTS	B	2.3	2.17%	300	6.51	2.17%	0.0206	0.045202	0
						∑np =	30.9				



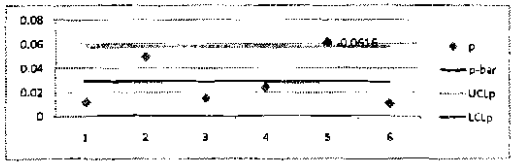
S. No.	Shift start	shift	Team	Thk.	% Defect	n	np	p	p-bar	UCLp	LCLp
1	2/6/2007 18:30	NIGHTS	B	3.0	0.96%	300	2.88	0.96%	0.008325	0.024063	0
2	2/25/2007 18:30	NIGHTS	B	3.0	0.61%	300	1.83	0.61%	0.008325	0.024063	0
3	1/8/2007 18:30	NIGHTS	B	3.0	0.91%	300	2.73	0.91%	0.008325	0.024063	0
4	12/12/2006 19:00	NIGHTS	B	3.0	0.85%	300	2.55	0.85%	0.008325	0.024063	0
						∑np =	9.99				



S. No.	Shift start	shift	Team	Thk.	% Defect	n	np	p	p-bar	UCLp	LCLp
1	2/14/2007 18:30	NIGHTS	B	3.1	3.47%	300	10.41	0.0347	0.018977	0.04261	0
2	2/15/2007 18:30	NIGHTS	B	3.1	1.59%	300	4.77	0.0159	0.018977	0.04261	0
3	2/24/2007 18:30	NIGHTS	B	3.1	1.28%	300	3.84	0.0128	0.018977	0.04261	0
4	1/9/2007 18:30	NIGHTS	B	3.1	1.34%	300	4.02	0.0134	0.018977	0.04261	0
5	1/17/2007 18:30	NIGHTS	B	3.1	2.13%	300	6.39	0.0213	0.018977	0.04261	0
6	1/18/2007 18:30	NIGHTS	B	3.1	1.61%	300	4.83	0.0161	0.018977	0.04261	0
7	1/28/2007 18:30	NIGHTS	B	3.1	2.88%	300	8.64	0.0288	0.018977	0.04261	0
8	12/3/2006 19:00	NIGHTS	B	3.1	0.86%	300	2.58	0.0086	0.018977	0.04261	0
9	12/20/2006 19:00	NIGHTS	B	3.1	3.15%	300	9.45	0.0315	0.018977	0.04261	0
10	12/21/2006 19:00	NIGHTS	B	3.1	2.65%	300	7.95	0.0265	0.018977	0.04261	0
11	12/29/2006 19:00	NIGHTS	B	3.1	1.53%	300	4.59	0.0153	0.018977	0.04261	0
12	12/30/2006 19:00	NIGHTS	B	3.1	1.19%	300	3.57	0.0119	0.018977	0.04261	0
13	12/31/2006 19:00	NIGHTS	B	3.1	0.99%	300	2.97	0.0099	0.018977	0.04261	0
						∑np =	74.01				



S. No.	Shift start	shift	Team	Thk	% Defect	n	np	p	p-bar	UCLp	LCLp
1	2/23/2007 18:30	NIGHTS	B	3.9	1.18%	300	3.54	0.0118	0.0288	0.057768	0
2	1/26/2007 18:30	NIGHTS	B	3.9	4.92%	300	14.76	0.0492	0.0288	0.057768	0
3	12/1/2006 19:00	NIGHTS	B	3.9	1.52%	300	4.56	0.0152	0.0288	0.057768	0
4	12/12/2006 19:00	NIGHTS	B	3.9	2.39%	300	7.17	0.0239	0.0288	0.057768	0
5	12/20/2006 19:00	NIGHTS	B	3.9	6.16%	300	18.48	0.0616	0.0288	0.057768	0
6	12/30/2006 19:00	NIGHTS	B	3.9	1.11%	300	3.33	0.0111	0.0288	0.057768	0
						∑np =	51.84				

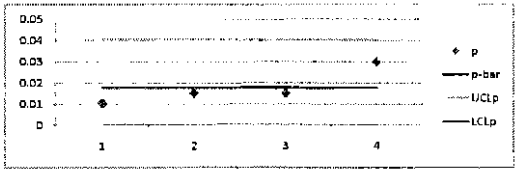


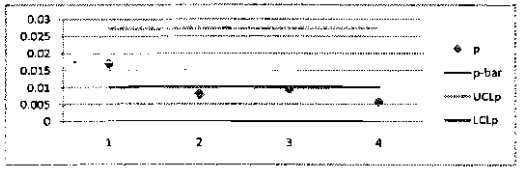
S. No.	Shift start	shift	Team	Thk.	% Defect	n	np	p	p-bar	UCLp	LCLp
1	2/22/2007 18:30	NIGHTS	C	2.3	1.03%	300	3.09	0.0103	0.0176	0.040375	0
2	1/15/2007 18:30	NIGHTS	C	2.3	1.50%	300	4.5	0.015	0.0176	0.040375	0
3	1/25/2007 18:30	NIGHTS	C	2.3	1.51%	300	4.53	0.0151	0.0176	0.040375	0
4	12/18/2006 19:00	NIGHTS	C	2.3	3.00%	300	9	0.03	0.0176	0.040375	0
						∑np =	21.12				

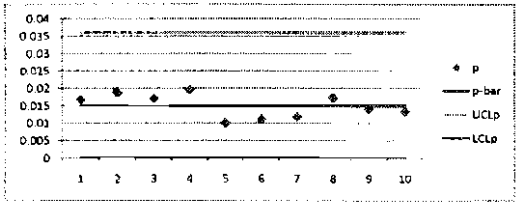
S. No	Shift start	shift	Team	Thk	% Defect	n	np	p	p-bar	UCLp	LCLp
1	2/13/2007 18:30	NIGHTS	C	3.0	1.70%	300	5.1	0.017	0.01005	0.027326	0
2	1/16/2007 18:30	NIGHTS	C	3.0	0.80%	300	2.4	0.008	0.01005	0.027326	0
3	12/19/2006 19:00	NIGHTS	C	3.0	0.94%	300	2.82	0.0094	0.01005	0.027326	0
4	12/27/2006 19:00	NIGHTS	C	3.0	0.58%	300	1.74	0.0058	0.01005	0.027326	0
						∑np =	12.06				

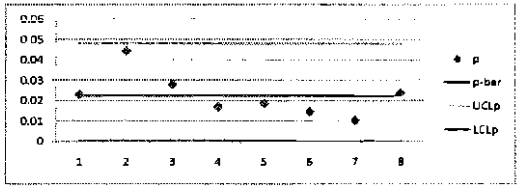
S. No	Shift start	shift	Team	Thk	% Defect	n	np	p	p-bar	UCLp	LCLp
1	2/4/2007 18:30	NIGHTS	C	3.1	1.67%	300	5.01	0.0167	0.01498	0.03602	0
2	2/21/2007 18:30	NIGHTS	C	3.1	1.88%	300	5.64	0.0188	0.01498	0.03602	0
3	2/22/2007 18:30	NIGHTS	C	3.1	1.72%	300	5.16	0.0172	0.01498	0.03602	0
4	1/6/2007 18:30	NIGHTS	C	3.1	1.95%	300	5.85	0.0195	0.01498	0.03602	0
5	1/7/2007 18:30	NIGHTS	C	3.1	1.00%	300	3	0.01	0.01498	0.03602	0
6	1/16/2007 18:30	NIGHTS	C	3.1	1.11%	300	3.33	0.0111	0.01498	0.03602	0
7	1/24/2007 18:30	NIGHTS	C	3.1	1.18%	300	3.54	0.0118	0.01498	0.03602	0
8	1/25/2007 18:30	NIGHTS	C	3.1	1.73%	300	5.19	0.0173	0.01498	0.03602	0
9	12/10/2006 19:00	NIGHTS	C	3.1	1.40%	300	4.2	0.014	0.01498	0.03602	0
10	12/28/2006 19:00	NIGHTS	C	3.1	1.34%	300	4.02	0.0134	0.01498	0.03602	0
						∑np =	44.94				

S. No	Shift start	shift	Team	Thk	% Defect	n	np	p	p-bar	UCLp	LCLp
1	2/2/2007 18:30	NIGHTS	C	3.9	2.29%	300	6.87	0.0229	0.022388	0.048011	0
2	2/13/2007 18:30	NIGHTS	C	3.9	4.43%	300	13.29	0.0443	0.022388	0.048011	0
3	2/21/2007 18:30	NIGHTS	C	3.9	2.79%	300	8.37	0.0279	0.022388	0.048011	0
4	1/8/2007 18:30	NIGHTS	C	3.9	1.68%	300	5.04	0.0168	0.022388	0.048011	0
5	1/16/2007 18:30	NIGHTS	C	3.9	1.88%	300	5.64	0.0188	0.022388	0.048011	0
6	12/8/2006 19:00	NIGHTS	C	3.9	1.45%	300	4.35	0.0145	0.022388	0.048011	0
7	12/9/2006 19:00	NIGHTS	C	3.9	1.01%	300	3.03	0.0101	0.022388	0.048011	0
8	12/28/2006 19:00	NIGHTS	C	3.9	2.36%	300	7.14	0.0238	0.022388	0.048011	0
						∑np =	53.73				

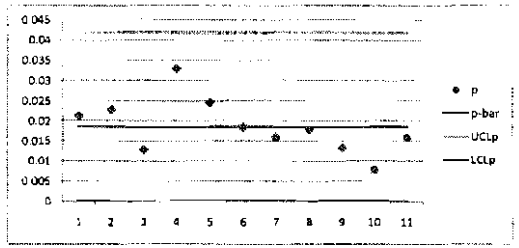




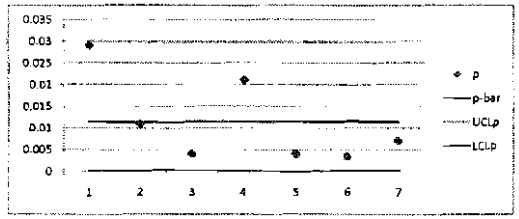




S. No.	Shift start	shift	Team	Thk	% Defect	n	np	p	p-bar	UCLp	LCLp
1	2/7/2007 18:30	NIGHTS	D	3.1	2.12%	300	6.36	0.0212	0.018527	0.041883	0
2	2/8/2007 18:30	NIGHTS	D	3.1	2.28%	300	6.84	0.0228	0.018527	0.041883	0
3	2/16/2007 18:30	NIGHTS	D	3.1	1.29%	300	3.87	0.0129	0.018527	0.041883	0
4	1/10/2007 18:30	NIGHTS	D	3.1	3.29%	300	9.87	0.0329	0.018527	0.041883	0
5	1/11/2007 18:30	NIGHTS	D	3.1	2.45%	300	7.34828	0.024494	0.018527	0.041883	0
6	1/20/2007 18:30	NIGHTS	D	3.1	1.84%	300	5.52	0.0184	0.018527	0.041883	0
7	1/21/2007 18:30	NIGHTS	D	3.1	1.59%	300	4.77	0.0159	0.018527	0.041883	0
8	12/13/2006 19:00	NIGHTS	D	3.1	1.79%	300	5.37	0.0179	0.018527	0.041883	0
9	12/14/2006 19:00	NIGHTS	D	3.1	1.35%	300	4.05	0.0135	0.018527	0.041883	0
10	12/22/2006 19:00	NIGHTS	D	3.1	0.79%	300	2.37	0.0079	0.018527	0.041883	0
11	12/24/2006 19:00	NIGHTS	D	3.1	1.58%	300	4.77	0.0159	0.018527	0.041883	0
						∑np =	61.13828				



S. No.	Shift start	shift	Team	Thk	% Defect	n	np	p	p-bar	UCLp	LCLp
1	2/7/2007 18:30	NIGHTS	D	3.9	2.90%	300	8.7	0.029	0.011414	0.029813	0
2	2/16/2007 18:30	NIGHTS	D	3.9	1.11%	300	3.33	0.0111	0.011414	0.029813	0
3	2/27/2007 18:30	NIGHTS	D	3.9	0.40%	300	1.2	0.004	0.011414	0.029813	0
4	1/19/2007 18:30	NIGHTS	D	3.9	2.11%	300	6.33	0.0211	0.011414	0.029813	0
5	1/30/2007 18:30	NIGHTS	D	3.9	0.41%	300	1.23	0.0041	0.011414	0.029813	0
6	12/22/2006 19:00	NIGHTS	D	3.9	0.35%	300	1.05	0.0035	0.011414	0.029813	0
7	12/23/2006 19:00	NIGHTS	D	3.9	0.71%	300	2.13	0.0071	0.011414	0.029813	0
						∑np =	23.97				



S. No.	Shift start	shift	Team	Thk	% Defect	n	np	p	p-bar	UCLp	LCLp
1	2/17/2007 18:30	NIGHTS	D	4.7	0.68%	300	2.04	0.0068	0.01545	0.036812	0
2	2/18/2007 18:30	NIGHTS	D	4.7	2.42%	300	7.26	0.0242	0.01545	0.036812	0
3	2/27/2007 18:30	NIGHTS	D	4.7	2.17%	300	6.51	0.0217	0.01545	0.036812	0
4	12/23/2006 19:00	NIGHTS	D	4.7	0.91%	300	2.73	0.0091	0.01545	0.036812	0
						∑np =	18.54