

Presenting ...

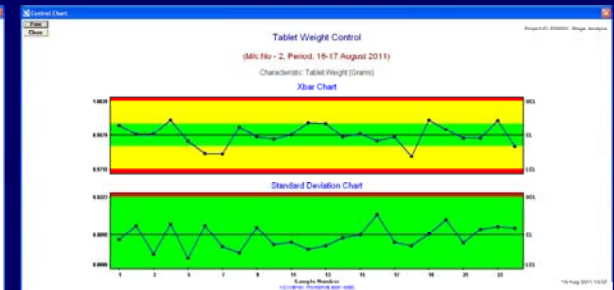
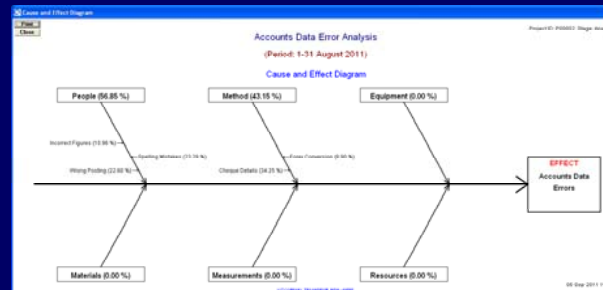
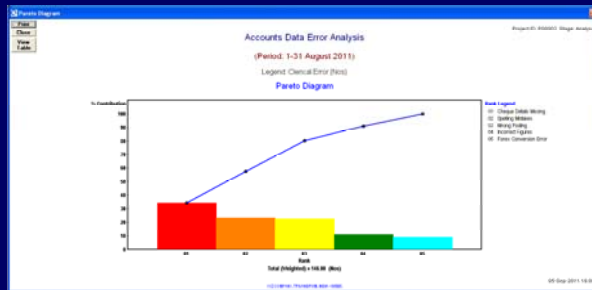
# Fact Based Management Tools<sup>(R)</sup>

Module: SPC / EPC / Six Sigma

Version 7.2 for Windows XP and later editions.

Computer Software for

Statistical Process Control (SPC), Engineering Process Control (EPC), and, Six Sigma Process Improvement



In this simple demo, our software is presented in the form of a series of screen-shots. It would give you the feel of how the actual software works and looks like.

Narrative is on the bottom panel of each slide. Concepts and features are explained through two enlightening six sigma projects (one from service industry and one from manufacturing industry).

Please press 'Enter' or 'Arrow' keys on the keyboard to browse the slides at your own pace.

# Process Improvement using SPC / EPC / Six Sigma Tools

There is a pressing need for the continual improvement of manufacturing and service processes in today's competitive business environment.

You may follow the time-tested Six Sigma DMAIC approach (Define, Measure, Analyse, Improve, and, Control) in any improvement initiative.

For this, you need to ...

1. Identify the areas for improvement
2. Identify the key input & output variables (KIVs & KOVs) that are critical to quality/schedule/cost
3. Collect the relevant data and analyse them using the SPC tools such as C&E Diagram, Pareto, Histogram, Scatter Plot, Control Chart, etc.
4. Take corrective and preventive actions to improve the process, and
5. Install an on-going control scheme (such as SPC or EPC chart) to sustain the improvement.

## What is SPC ?

Statistical Process control (SPC) is a scientific and inexpensive way to prevent defects. It is an effective check against assignable causes of process variation. You would require SPC tools for every Six Sigma project.

## When to use EPC ?

Once a process is brought to stable condition using SPC charts, Engineering Process Control (EPC) helps in predicting the process performance and pro-active adjustments, thereby reducing process variability. It adds extra power to your process control schemes.

Both SPC and EPC are very essential for achieving the PPM (parts per million) defect levels expected of your Six Sigma initiatives.

**In this context, it is very important to provide a statistical software to your personnel for error-free data analysis and charting on regular basis.**

Our **FBM Tools – SPC/EPC/Six Sigma module** is a Windows-based computer program designed specifically for improvement projects, by seasoned Engineer-Statistician experts (alumni of the Indian Statistical Institute).

Before getting into the details of the software, let us look at one example project from service industry and one from manufacturing industry, to learn how to put SPC/EPC/Six Sigma tools to use.

[Please see the software screens and read the narrative at the bottom panel.](#)

**Six Sigma Project Information Database**

Project ID:  <- Enter a unique ID. Project Status:

Reason for Project:

Project Title:

Project Objective:

Project Description:

Project Leader:  Job Title:

**My Projects** | 1. Define | 2. Measure | 3. Analyse | 4. Improve | 5. Control | Results

ProjectID	ProjectTitle	ProjectObjective	ProjectReason	ProjectDescription	ProjectLeaderUserID	ProjectLeaderName
P00001	Tablet Weight Control	To reduce weight variat	Rejection due to weight	This is for on-going SPC	stanley	Stanley J
P00002	Accounts Data Quality I	To reduce errors in acc	Errors in a/c records		stanley	Stanley J

2 of 2

## Example Project (Service Industry)

In a certain company, there were chronic data entry problems in the Accounts Department. As part of its Six Sigma initiatives, the company's management has decided to study the data entry errors by collecting the data for one month and analysing it. The company has designated its Manager, **Mr. Stanley John** as the **Project Leader**.

Mr. John has created a project record by going to the menu item **File** ➤ **Manage My Projects**

Row No	Col 001	Col 002	Col 003	Col 004	Col 005	Col 006	Col 007	Col 008
0	Date	Total No. of Records	Wrong Posting	Incorrect Figures	Cheque Details Missing	Forex Conversion Error	Spelling Mistakes	TOTAL ERRORS
1	01-Aug-2011	1236	2	1	3	0	1	7
2	02-Aug-2011	863	1	0	0	0	1	2
3	03-Aug-2011	615	0	1	0	0	0	1
4	04-Aug-2011	1367	7	1	4	2	5	19
5	05-Aug-2011	231	1	0	0	0	0	1
6	06-Aug-2011	653	0	0	0	2	0	2
7	08-Aug-2011	532	0	0	0	0	0	0
8	09-Aug-2011	981	2	2	1	1	0	6
9	10-Aug-2011	651	0	0	3	2	3	8
10	11-Aug-2011	874	6	2	1	0	5	14
11	12-Aug-2011	679	0	0	4	0	6	10
12	13-Aug-2011	652	1	0	1	0	0	2
13	16-Aug-2011	84	0	0	0	1	0	1
14	17-Aug-2011	895	1	0	2	0	0	3
15	18-Aug-2011	786	0	1	2	0	2	5
16	19-Aug-2011	675	0	0	1	1	0	2
17	20-Aug-2011	958	3	1	5	1	0	10
18	22-Aug-2011	482	0	0	1	1	1	3
19	23-Aug-2011	826	1	0	0	1	0	2
20	24-Aug-2011	547	2	0	3	0	2	7
21	25-Aug-2011	756	1	1	2	0	2	6
22	26-Aug-2011	537	0	1	6	0	3	10
23	27-Aug-2011	765	2	1	3	0	2	8
24	29-Aug-2011	425	1	2	1	1	0	5
25	31-Aug-2011	765	2	2	7	0	1	12

## Example Project (Service Industry)

Then he created a new data file by going to the menu item **File** ➤ **New Data File**.

After that, he entered the data collected in August 2011 and saved the file.

**Data Analysis Work Book: Pareto Analysis**

Six Sigma Project ID: P00002 Project Phase: Analyse

Main Title: Accounts Data Error Analysis

Sub Title: (Period: 1-31 August 2011)

Data File Name: Prj2\_data.xls Browse View Datafile

Legend Name: Clerical Error Data Unit: Nos

Legend Row No: 0  Draw Colour-filled Bars

Data Columns: From 3 To 7  Apply Weightage

Data Rows : From 1 To 25 Weightage Row No:

Decimal places in output: 2 <- 0 to 4

General Notes:

Name of Process: Accounts Data Entry

Name of Analyst: Stanley John

**START ANALYSIS NOW**

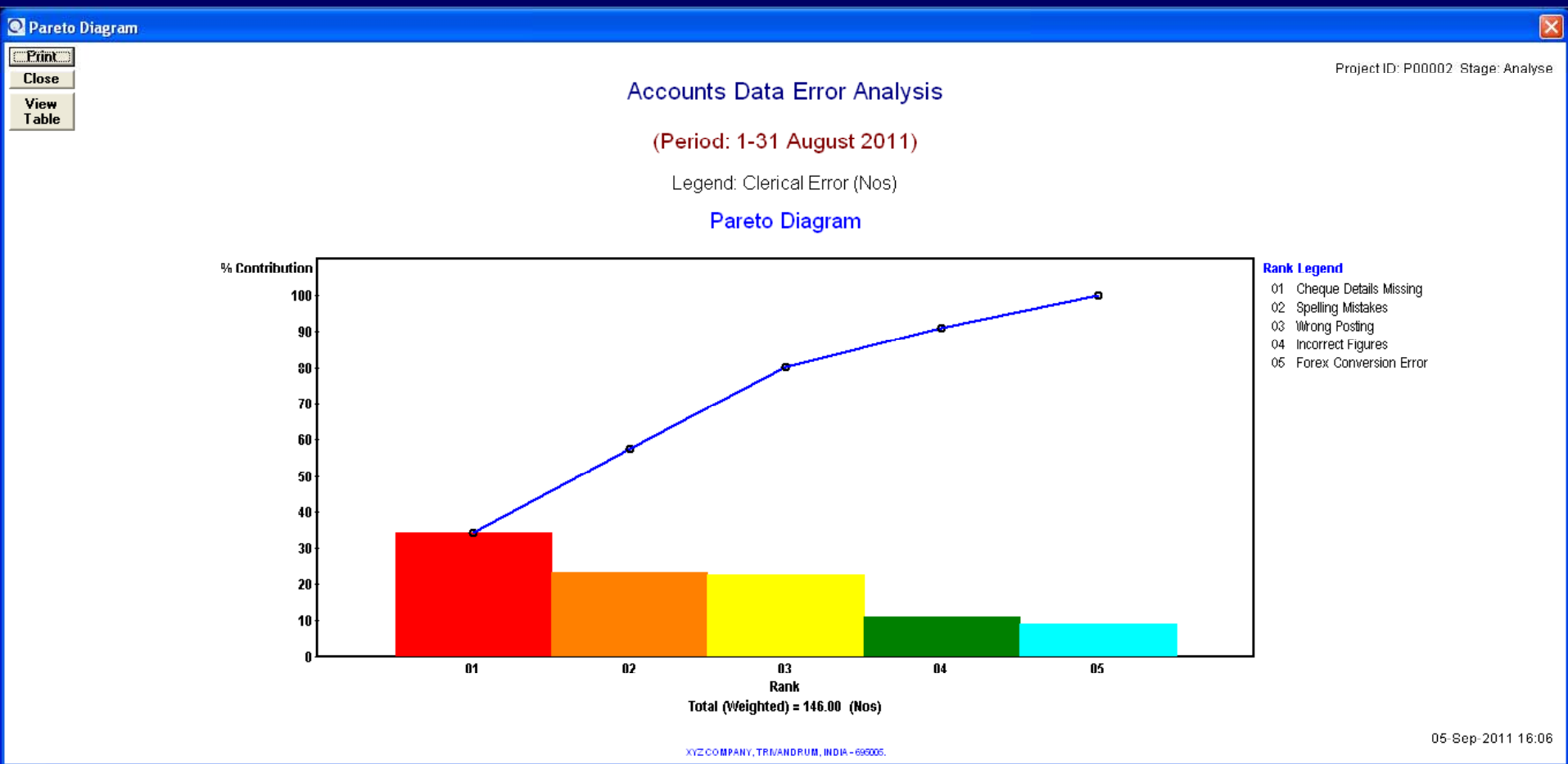
Add New Record Goto Workbook ID -> Save / Update Delete Refresh Close

Workbook ID: 2 (Total 1 records)

## Example Project (Service Industry)

Looking at the data, he decided to first carry out a Pareto Analysis.

For this he went to the menu item **File** ➤ **Manage My Workbooks / Start Data Analysis** ➤ **Pareto Analysis** and created a workbook record.



**Example Project (Service Industry)**

When he clicked on the 'START ANALYSIS NOW' button, the software has displayed the Pareto Diagram.

Pareto Table Project ID: P00002 Stage: Analyse

Print Close

### Accounts Data Error Analysis

(Period: 1-31 August 2011)

Legend: Clerical Error (Nos)

#### Pareto Analysis Table

Rank	Legend Name	Legend Total	Weightage	Wtd. Total	Contribution %	Cumulative %
01	Cheque Details Missing	50.00	1.00	50.00	34.25	34.25
02	Spelling Mistakes	34.00	1.00	34.00	23.29	57.53
03	Wrong Posting	33.00	1.00	33.00	22.60	80.14
04	Incorrect Figures	16.00	1.00	16.00	10.96	91.10
05	Forex Conversion Error	13.00	1.00	13.00	8.90	100.00
<b>GRAND TOTALS :</b>		<b>146.00</b>		<b>146.00</b>	<b>100.00</b>	

XYZ COMPANY, TRIVANDRUM, INDIA - 690005. 05-Sep-2011 16:08

**Example Project (Service Industry)**

And, when he clicked on the 'View Table' button, the Pareto Table was shown as above.

He has decided to present this Pareto output along with a Cause & Effect Diagram to the concerned data entry operators for further brainstorming and improvement.



**Data Analysis Work Book: Cause and Effect Diagram**

Six Sigma Project ID: P00002 Project Phase: Analyse

Display Name of Tool: Cause and Effect Diagram

Main Title: Accounts Data Error Analysis

Sub Title: (Period: 1-31 August 2011)

**Cause(s):**

Cause 1	Cause 2	Cause 3	Cause 4	Cause 5	Cause 6												
<p><b>Main Cause 1:</b> People <b>Contribution %</b> 56.85</p> <p>Sub Cause Legend(s):</p> <table border="1"> <thead> <tr> <th></th> <th>Contribution %</th> </tr> </thead> <tbody> <tr> <td>1. Wrong Posting</td> <td>22.6</td> </tr> <tr> <td>2. Spelling Mistakes</td> <td>23.29</td> </tr> <tr> <td>3. Incorrect Figures</td> <td>10.96</td> </tr> <tr> <td>4.</td> <td>0</td> </tr> <tr> <td>5.</td> <td>0</td> </tr> </tbody> </table>		Contribution %	1. Wrong Posting	22.6	2. Spelling Mistakes	23.29	3. Incorrect Figures	10.96	4.	0	5.	0					
	Contribution %																
1. Wrong Posting	22.6																
2. Spelling Mistakes	23.29																
3. Incorrect Figures	10.96																
4.	0																
5.	0																

**Effect:** Accounts Data Errors

Notes:

Process: Accounts Data Entry

Analyst: Stanley John

Report contribution % for Main Causes  
 Report contribution % for Sub Causes also

Decimal places in output: 2 < 0 to 4

**START ANALYSIS NOW**

Add New Record Goto Workbook ID -> Save / Update Delete Refresh Close

Workbook ID: 1 (Total 1 records)

## Example Project (Service Industry)

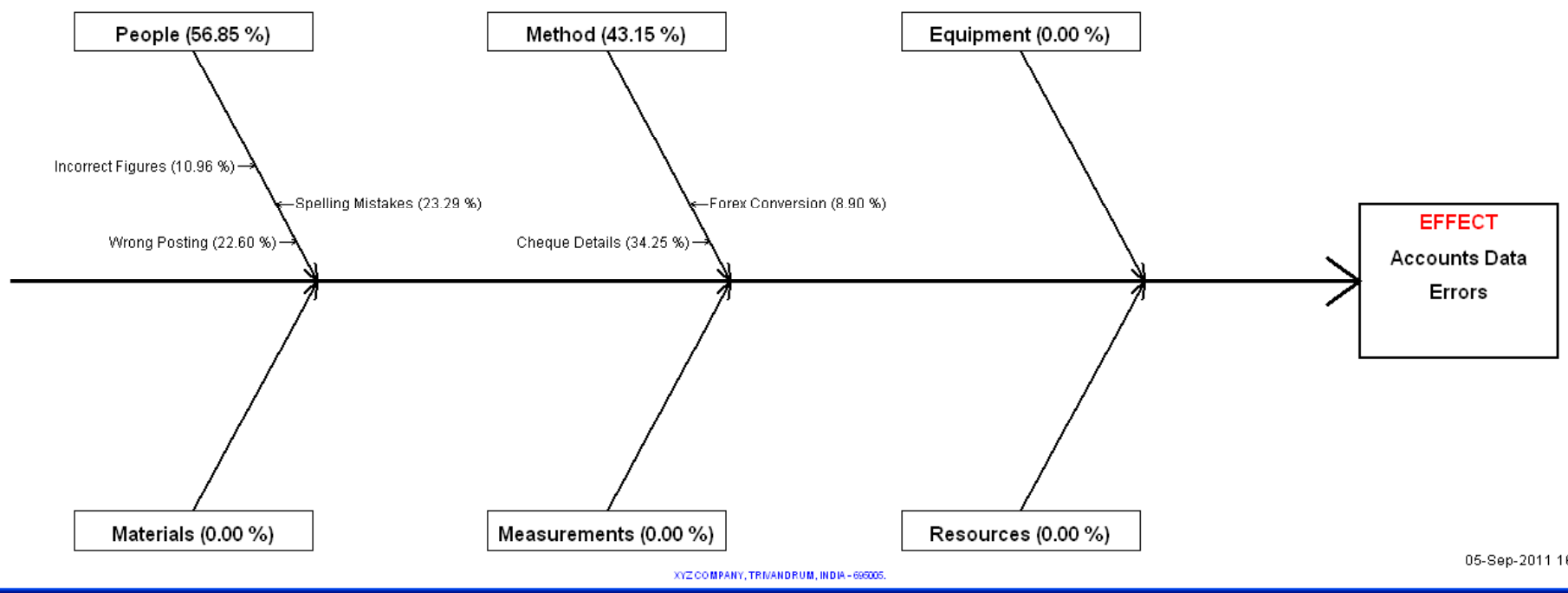
He has also decided to group the errors under six categories (variation of Six M's) such as **People**, **Method**, **Equipment**, **Resources**, **Measurements**, and, **Materials**.

He went to the menu item **File** ➤ **Manage My Workbooks / Start Data Analysis** ➤ **Cause and Effect Diagram** and created a workbook record.

### Accounts Data Error Analysis

(Period: 1-31 August 2011)

### Cause and Effect Diagram



## Example Project (Service Industry)

When he clicked on the 'START ANALYSIS NOW' button, the software has displayed the Cause & Effect Diagram.

**Data Analysis Work Book: SPC Charts and Histogram**

Six Sigma Project ID: P00002 Project Phase: Analyse

Analysis Title: Accounts Data Error Monitoring

SubTitle: (Period: 1-31 August 2011)

Characteristic (Y): Clerical Errors Measurement Unit: Nos/Record

Basic SPC Chart: Defects/Unit (u) Chart Type: Conventional

Homogenisation Rule: Stop when 25% samples are dropped  Draw control charts with colour bands

**Data Input** Specifications SPC Parameters EPC Parameters Process Info.

Data File: Prj2\_data.fts Browse View Datafile

Data Columns: From 8 To 8

Data Rows: From 1 To 25

Sample Size Column: 2 <- for p, np, and u charts only.

Nominal Value Column: <- for short run chart type only.

Decimal places required in numeric output: 4 <- between 0 and 9 only.

**Option for Control Chart Limits:** Computed from data **START ANALYSIS NOW**

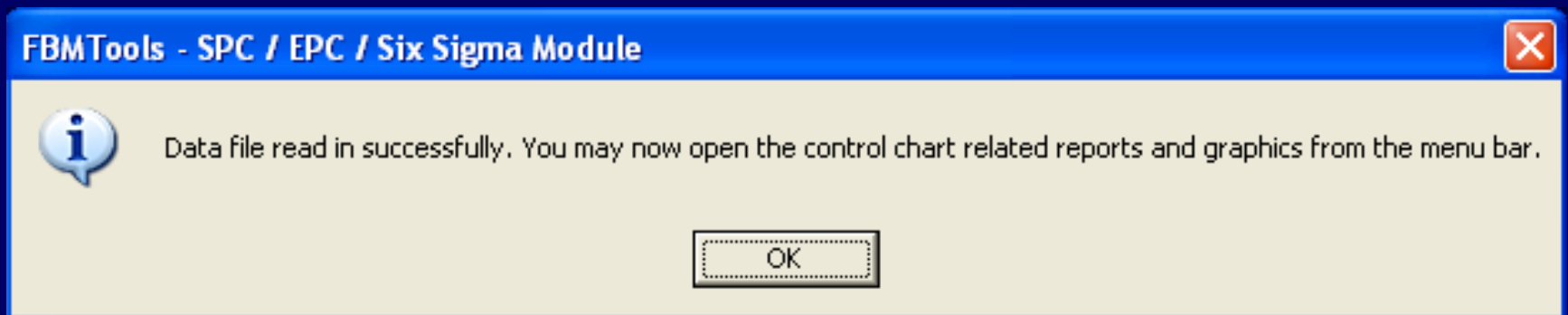
Add New Record Goto Workbook ID -> Save / Update Delete Refresh Close

Workbook ID: 1 (Total 2 records)

## Example Project (Service Industry)

Also, the project leader wanted to get an estimate of the current levels of *Six Sigma Metrics* of the data entry process. For this, he has decided to open a control chart workbook and use the u-chart.

To setup u-chart, the project leader has gone to the menu item **File** ➤ **Manage My Workbooks / Start Data Analysis** ➤ **Control Chart and Histogram** and created a workbook record.



## Example Project (Service Industry)

When he clicked on the 'START ANALYSIS NOW' button, the software has displayed the above message.

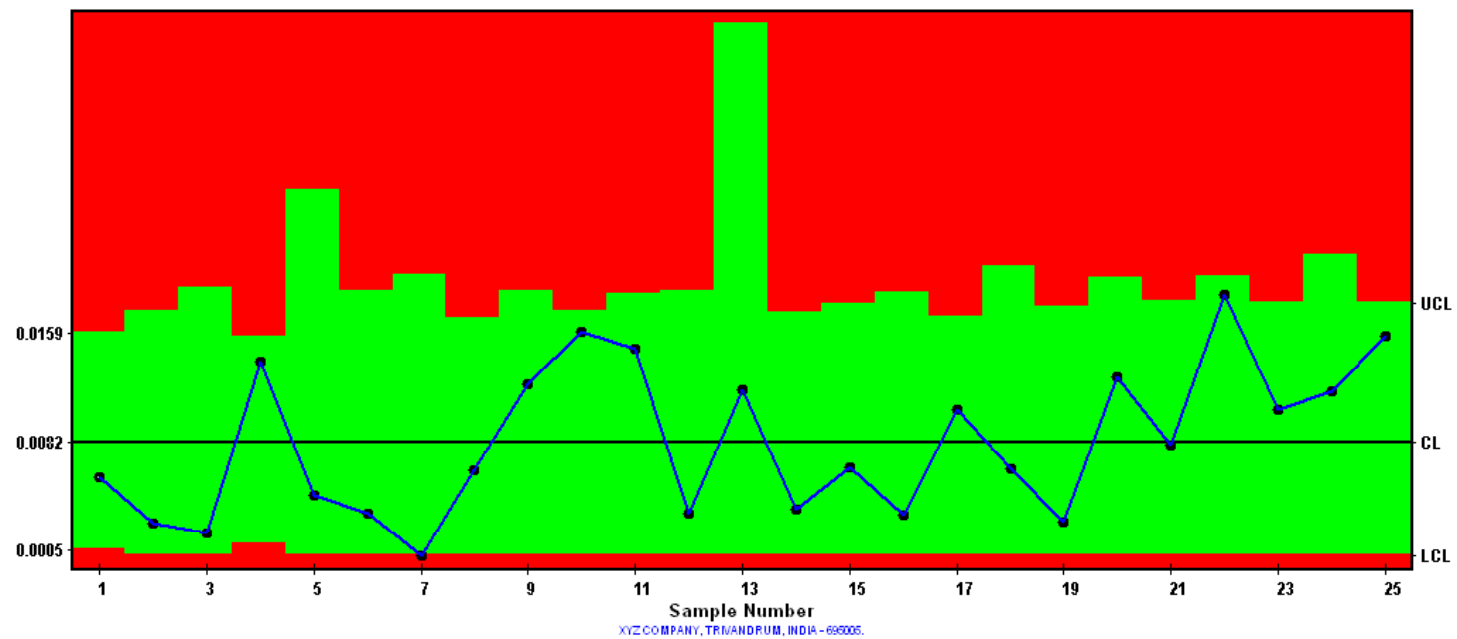
To view the control chart, he has gone to the menu item **Graphics** > **Control Charts** and clicked open the menu.

### Accounts Data Error Monitoring

(Period: 1-31 August 2011)

Characteristic: Clerical Errors (Nos/Record)

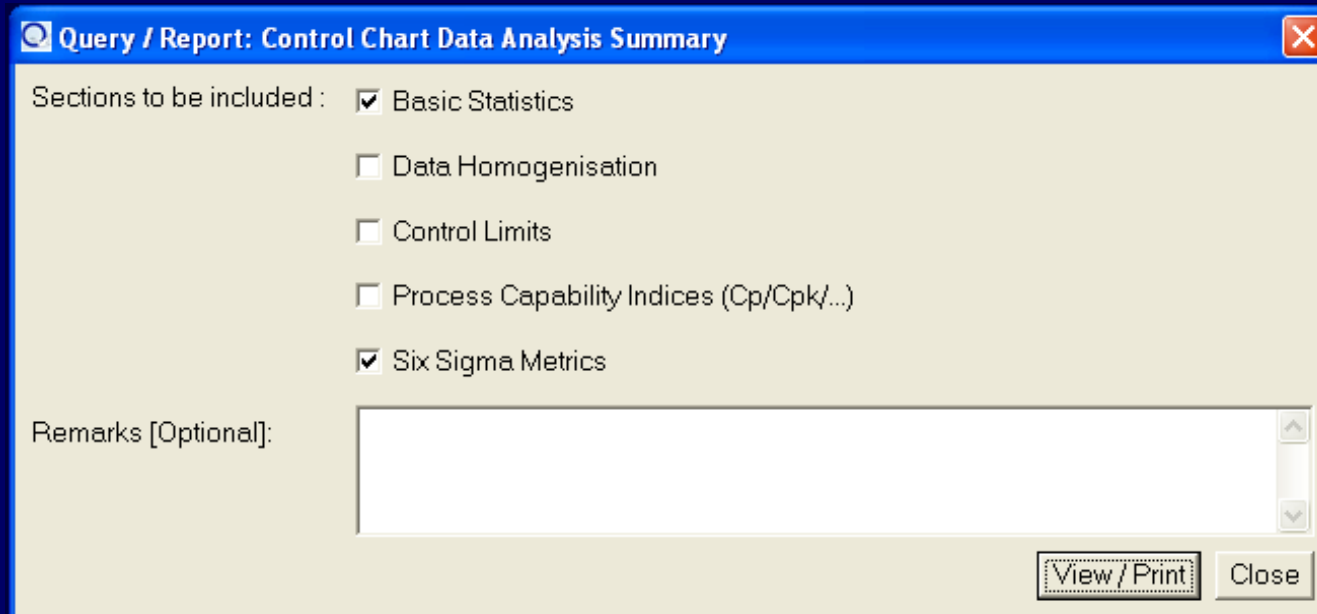
u-Chart



### Example Project (Service Industry)

The following control chart (u-chart) was displayed.

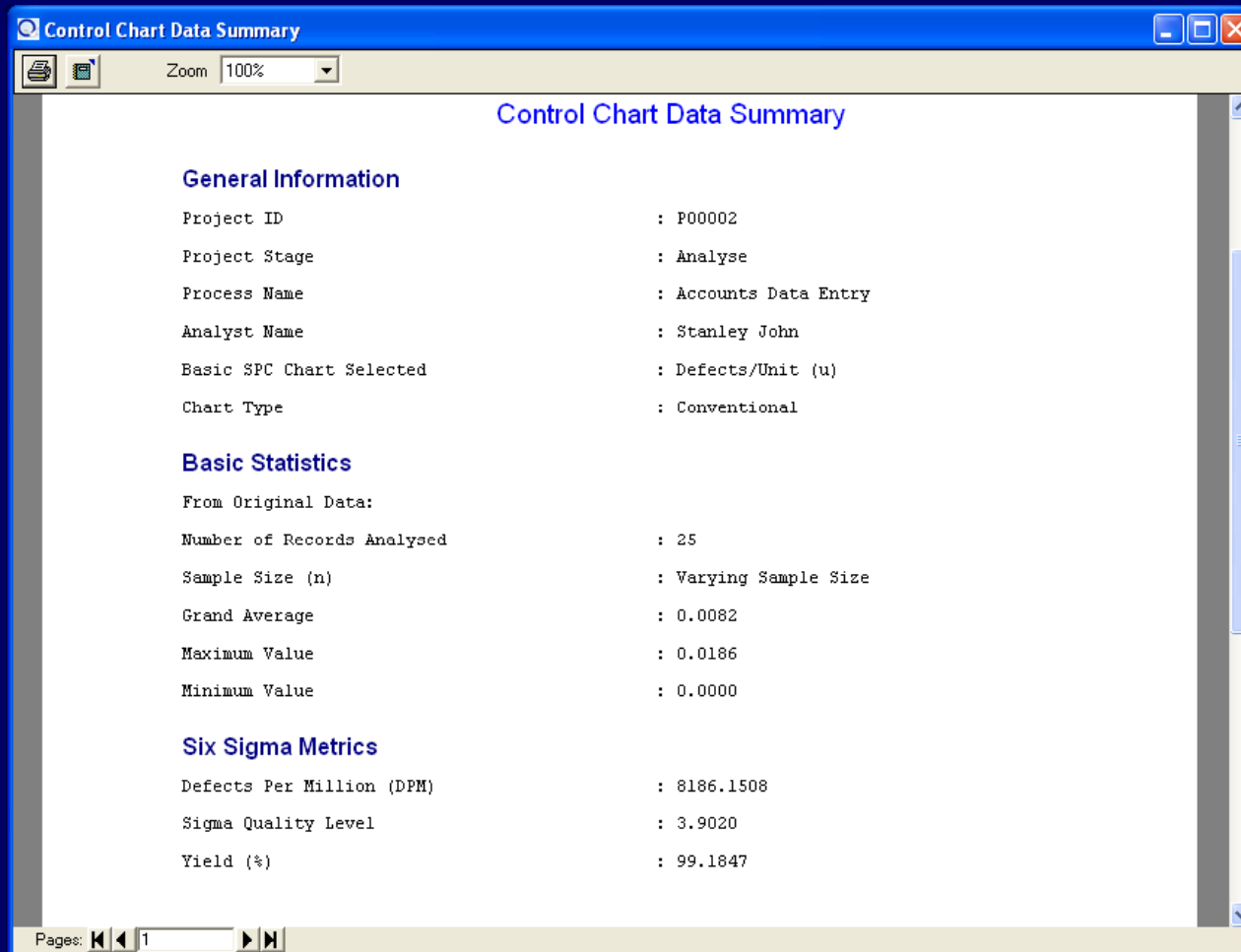
As the sample sizes were varying, the chart was drawn with varying control limits (not as straight lines). Areas within control limits shown in green colour, and areas outside limits in red colour.



## Example Project (Service Industry)

To view the Six Sigma metrics, he has gone to the menu item **Reports** ➤ **Control Chart Data Summary** and clicked open the menu as above.

After checking the required sections in the report, he hit the 'View/Print' button to view the report.



## Example Project (Service Industry)

Having done the preliminary data analysis, it is now time for brainstorming and improvement.

## Example Project (Service Industry)

### Brain Storming & Improvement:

Looking at the Pareto Analysis, Cause & Effect Diagram, and the Control Chart, the data entry operators as well as the project leader agreed that the root causes of the problem were:

1. **People** (Human errors – spelling mistakes and wrong postings), and
2. **Method** (Procedural flaws in communicating cheque details)

It was decided ...

- to impart training to all data entry operators on accounting concepts (correct posting)
- to enable automatic spell-check facility of the accounting software, and also to keep dictionary CDs at data entry work stations
- to re-write the integrated management system (IMS) work instructions in such a way that cheque details would never be lost in the communication process, and
- to continue with the u-chart for monitoring the day-to-day error levels.

Let's see what was the result of implementing the corrective actions:



Prj2\_data.xls

Row No	Col 001	Col 002	Col 003	Col 004	Col 005	Col 006	Col 007	Col 008
19	23-Aug-2011	826	1	0	0	1	0	2
20	24-Aug-2011	547	2	0	3	0	2	7
21	25-Aug-2011	756	1	1	2	0	2	6
22	26-Aug-2011	537	0	1	6	0	3	10
23	27-Aug-2011	765	2	1	3	0	2	8
24	29-Aug-2011	425	1	2	1	1	0	5
25	31-Aug-2011	765	2	2	7	0	1	12
26								
27	After Improvements							
28								
29	12-Sept-2011	988	1	0	0	0	0	1
30	13-Sept-2011	374	0	0	0	0	0	0
31	14-Sept-2011	1123	0	0	0	1	1	2
32	15-Sept-2011	538	0	0	0	0	0	0
33	16-Sept-2011	1009	0	0	0	0	0	0
34	17-Sept-2011	788	0	0	0	0	0	0
35	19-Sept-2011	862	0	0	0	0	0	0
36	20-Sept-2011	1046	0	0	0	1	0	1
37	21-Sept-2011	850	1	0	0	0	0	1
38	22-Sept-2011	493	0	0	0	0	0	0
39	23-Sept-2011	835	0	0	0	0	0	0
40	24-Sept-2011	759	0	0	0	0	0	0
41	26-Sept-2011	1081	0	0	0	0	0	0
42	27-Sept-2011	1257	0	1	0	1	0	2
43	28-Sept-2011	1180	0	0	0	1	0	1
44	29-Sept-2011	806	0	1	0	0	1	2
45	30-Sept-2011	733	0	0	0	0	0	0
46								

Append Row Save / Update Insert Row Above Delete Row Column Operations Refresh Close

Record: 1 \*\*\* Please do not edit row numbers. Software manages it by itself. \*\*\*

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## Example Project (Service Industry)

See the freshly collected data for September 2011.

**Data Analysis Work Book: SPC Charts and Histogram**

Six Sigma Project ID: P00002 Project Phase: Control

Analysis Title: Accounts Data Error Monitoring

Sub Title: (Period: 12-30 September 2011)

Characteristic (Y): Clerical Errors Measurement Unit: Nos/Record

Basic SPC Chart: Defects/Unit (u) Chart Type: Conventional

Homogenisation Rule: Stop when 25% samples are dropped  Draw control charts with colour bands

**Data Input** Specifications SPC Parameters EPC Parameters Process Info.

Data File: Prj2\_data.fts Browse View Datafile

Data Columns: From 8 To 8

Data Rows: From 29 To 45

Sample Size Column: 2 <- for p, np, and u charts only.

Nominal Value Column: <- for short run chart type only.

Decimal places required in numeric output: 4 <- between 0 and 9 only.

Option for Control Chart Limits: Computed from data **START ANALYSIS NOW**

Add New Record Goto Workbook ID -> Save / Update Delete Refresh Close

Workbook ID: 1 (Total 2 records)

## Example Project (Service Industry)

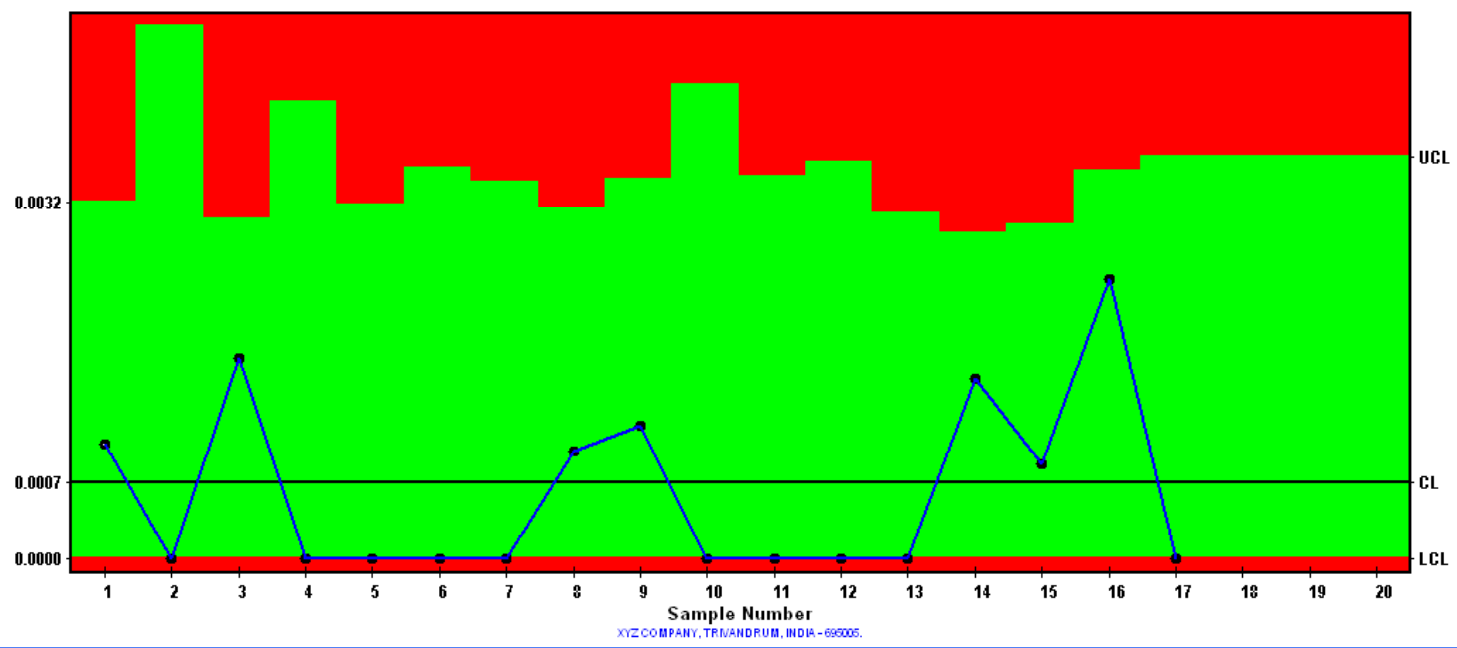
See the (modified) workbook entries for u-chart.

### Accounts Data Error Monitoring

(Period: 12-30 September 2011)

Characteristic: Clerical Errors (Nos/Record)

u-Chart



## Example Project (Service Industry)

See the u-chart for September 2011.

The screenshot shows a software window titled "Control Chart Data Summary". The window has a blue title bar and a toolbar with icons for print, save, and zoom. The zoom is set to 100%. The main content area is white and contains the following information:

### Control Chart Data Summary

**General Information**

Project ID	: P00002
Project Stage	: Control
Process Name	: Accounts Data Entry
Analyst Name	: Stanley John
Basic SPC Chart Selected	: Defects/Unit (u)
Chart Type	: Conventional

**Basic Statistics**

From Original Data:

Number of Records Analysed	: 17
Sample Size (n)	: Varying Sample Size
Grand Average	: 0.0007
Maximum Value	: 0.0025
Minimum Value	: 0.0000

**Six Sigma Metrics**

Defects Per Million (DPM)	: 679.2555
Sigma Quality Level	: 4.7030
Yield (%)	: 99.9321

At the bottom of the window, there is a page navigation bar showing "Pages: 1" with navigation arrows.

## Example Project (Service Industry)

See the improved Six Sigma Metrics for September 2011. Prior to Six Sigma initiatives, these were:

Defects per Million (DPM)	: 8186.15
Sigma Quality Level	: 3.90
Yield (%)	: 99.18

**Hope that you liked the sample project from service industry.**

Now, let's see one example project from manufacturing industry.

## Example Project (Manufacturing Industry)

The following tools are covered in this example:

- Control Chart (Variable Data)
- Scatter Plot & Regression
- Engineering Process Control (EPC)

### Project Description:

In a certain pharmaceutical company that manufactures tablets, there was frequent rejection of final product due to off-the-spec tablet weight. As part of its Six Sigma initiatives, the company's management decided to study the tablet weight variations by collecting some data from the plant and analysing it.

The company has designated its Manager, **Mr. Stanley John** as the Project Leader and the Laboratory Technician **Ms. Ratna Raj** as team member.

Now, let's see how this very interesting project was executed.

**Six Sigma Project Information Database**

Project ID:  <- Enter a unique ID. Project Status:

Reason for Project:

Project Title:

Project Objective:

Project Description:

Project Leader:  Job Title:

**My Projects** | 1. Define | 2. Measure | 3. Analyse | 4. Improve | 5. Control | Results

	ProjectID	ProjectTitle	ProjectObjective	ProjectReason	ProjectDescription	ProjectLeaderUserID	ProjectLeaderName
▶	P00001	Tablet Weight Control	To reduce weight variations	Rejection due to weight variations	This is for on-going SPC implementation on the Tablet Making machine.	stanley	Stanley John
	P00002	Accounts Data Quality I	To reduce errors in accounts	Errors in a/c records		stanley	Stanley John

Record 1 of 2

## Example Project (Manufacturing Industry)

As the first step, the project leader has created a project record by going to the menu item **File** ➤ **Manage My Project Records**

**List of Project Team Members**

Project ID: P00001

User ID: ratna <- Select one from list

Name: Ratna Raj

Job Title: Lab Technician

Existing List of Team Members:

	ProjectID	UserID	UserName	UserJobTitle
▶	P00001	ratna	Ratna Raj	Lab Technician

◀ ▶

Add New Save / Update Delete Current Record Refresh Close

◀ ▶ 1 of 1

## Example Project (Manufacturing Industry)

Then, he entered the team information by clicking on the 'View / Edit the List of Team Members' button.



**List of Key Variables (Input and Output)**

Project ID:

Name of Variable:

Type:  Impact:

Existing list of KIV's and KOV's:

ProjectID	VariableName	Type	Impact
P00001	Feed Rate	Key Input Variable	Critical To Quality
P00001	Tablet Weight	Key Output Variable	Critical To Quality

1 of 2

## Example Project (Manufacturing Industry)

After that, he entered the key input and output variables by clicking on the 'View / Edit the List of Key Input and Output Variables (KIV's and KOV's)' button.

C:\Documents and Settings\ws\Desktop\SPC V7 Demo Data\tablet\_weight.xls

Row No	Col 001	Col 002	Col 003	Col 004	Col 005	Col 006	Col 007	Col 008
0	Date	Time	Weight-01	Weight-02	Weight-03	Weight-04	Average Weight	Feed Rate (X) kg/s
1	16-Aug-2011	06.00 Hrs	0.998	0.992	0.999	0.981	0.9925	2.05
2	16-Aug-2011	07.00 Hrs	0.995	1.002	0.983	0.973	0.9882	2.01
3	16-Aug-2011	08.00 Hrs	0.991	0.992	0.986	0.985	0.9884	2.02
4	16-Aug-2011	09.00 Hrs	0.991	0.995	0.981	1.013	0.9951	2.08
5	16-Aug-2011	10.00 Hrs	0.986	0.982	0.987	0.985	0.9849	1.98
6	16-Aug-2011	11.00 Hrs	0.986	0.974	0.964	0.993	0.9795	1.94
7	16-Aug-2011	12.00 Hrs	0.983	0.970	0.982	0.981	0.9789	1.93
8	16-Aug-2011	13.00 Hrs	0.995	0.986	0.994	0.992	0.9918	2.05
9	16-Aug-2011	14.00 Hrs	1.002	0.988	0.986	0.972	0.9869	2.00
10	16-Aug-2011	15.00 Hrs	0.986	0.993	0.988	0.977	0.9861	2.00
11	16-Aug-2011	16.00 Hrs	0.984	0.981	0.998	0.989	0.9881	2.01
12	16-Aug-2011	17.00 Hrs	1.000	0.989	0.996	0.990	0.9939	2.07
13	16-Aug-2011	18.00 Hrs	0.999	0.986	0.990	0.998	0.9932	2.06
14	16-Aug-2011	19.00 Hrs	0.989	0.993	0.992	0.974	0.9871	2.00
15	16-Aug-2011	20.00 Hrs	0.980	0.998	0.996	0.980	0.9886	2.02
16	16-Aug-2011	21.00 Hrs	0.992	0.998	0.961	0.990	0.9855	1.99
17	16-Aug-2011	22.00 Hrs	0.984	0.978	0.992	0.994	0.9870	2.00
18	16-Aug-2011	23.00 Hrs	0.985	0.976	0.970	0.980	0.9777	1.92
19	16-Aug-2011	24.00 Hrs	0.999	1.002	0.980	0.999	0.9951	2.08
20	17-Aug-2011	01.00 Hrs	0.978	0.979	0.996	1.009	0.9903	2.03
21	17-Aug-2011	02.00 Hrs	0.981	0.982	0.997	0.986	0.9865	2.00
22	17-Aug-2011	03.00 Hrs	0.981	0.976	0.986	1.003	0.9864	2.00
23	17-Aug-2011	04.00 Hrs	1.012	0.983	0.995	0.989	0.9945	2.07
24	17-Aug-2011	05.00 Hrs	0.990	0.984	0.991	0.965	0.9825	1.96
25								
26								
27								

Append Row Save / Update Insert Row Above Delete Row Column Operations Refresh Close

Record: 25 \*\*\* Please do not edit row numbers. Software manages it by itself. \*\*\*

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## Example Project (Manufacturing Industry)

Then he created a data file and entered the data that was collected with the help of team member.

**Data Analysis Work Book: SPC Charts and Histogram**

Six Sigma Project ID: P00001 Project Phase: Analyse

Analysis Title: Tablet Weight Control

SubTitle: (M/c No - 2, Period: 16-17 August 2011)

Characteristic (Y): Tablet Weight Measurement Unit: Grams

Basic SPC Chart: Xbar-S Chart Type: Conventional

Homogenisation Rule: Stop when 25% samples are dropped  Draw control charts with colour bands

**Data Input** Specifications SPC Parameters EPC Parameters Process Info.

Data File: tablet\_weight.xls Browse View Datafile

Data Columns: From 3 To 6

Data Rows: From 1 To 24

Sample Size Column:  <- for p, np, and u charts only.

Nominal Value Column:  <- for short run chart type only.

Decimal places required in numeric output: 4 <- between 0 and 9 only.

**Option for Control Chart Limits:** Computed from data **START ANALYSIS NOW**

Add New Record Goto Workbook ID ->  Save / Update Delete Refresh Close

Workbook ID: 2 (Total 2 records)

## Example Project (Manufacturing Industry)

After that he has created a workbook record for control chart.

**Data Analysis Work Book: SPC Charts and Histogram**

Six Sigma Project ID: P00001 Project Phase: Analyse

Analysis Title: Tablet Weight Control

SubTitle: (M/c No - 2, Period: 16-17 August 2011)

Characteristic (Y): Tablet Weight Measurement Unit: Grams

Basic SPC Chart: Xbar-S Chart Type: Conventional

Homogenisation Rule: Stop when 25% samples are dropped  Draw control charts with colour bands

Data Input Specifications SPC Parameters EPC Parameters Process Info.

**Technical Specifications: User-defined Control Limits for Mean / CV% / MA / CuSum / EWMA / UBM and Variation\***

<input checked="" type="checkbox"/> <b>USL</b>	1.04	<input type="checkbox"/> <b>UCL(X)*</b>		<input type="checkbox"/> <b>UCL [R/S/MR/MS]*</b>	
<input checked="" type="checkbox"/> <b>TGT</b>	1.00	<input type="checkbox"/> <b>CL(X)*</b>		<input type="checkbox"/> <b>CL [R/S/MR/MS]*</b>	
<input checked="" type="checkbox"/> <b>LSL</b>	0.96	<input type="checkbox"/> <b>LCL(X)*</b>		<input type="checkbox"/> <b>LCL [R/S/MR/MS]*</b>	

Important Note: When you opt for user-defined control limits, this software would draw the control charts using those limits only. This is usually done for real-time operator-level process monitoring, after the process is brought under statistical control. Normally, a senior person (say, the Quality Control In-charge) computes these limits periodically from old (recent) data using this software and updates the entries manually. The control limits must be revised as frequently as possible. Please read the user manual for more information.

Option for Control Chart Limits: Computed from data **START ANALYSIS NOW**

Add New Record Goto Workbook ID -> Save / Update Delete Refresh Close

Workbook ID: 2 (Total 2 records)

## Example Project (Manufacturing Industry)

He has then added details under 'Specifications' tab.

**Data Analysis Work Book: SPC Charts and Histogram**

Six Sigma Project ID: P00001 Project Phase: Analyse

Analysis Title: Tablet Weight Control

SubTitle: (M/c No - 2, Period: 16-17 August 2011)

Characteristic (Y): Tablet Weight Measurement Unit: Grams

Basic SPC Chart: Xbar-S Chart Type: Conventional

Homogenisation Rule: Stop when 25% samples are dropped  Draw control charts with colour bands

Data Input	Specifications	SPC Parameters	EPC Parameters	Process Info.
<b>Chart Type</b> <b>Required Parameters</b> (Figures in brackets are the recommended values.)				
Moving Average	Avg. Period (w):	2 (between 2 and 200 only.)		
Cu-Sum	Head Start (in Sigmas):	2.50 (2.50)	Reference Value, K (in Sigmas):	0.50 (0.50)
			Decision Interval, H (in Sigmas):	5.00 (5.00)
Cu-Sum or EWMA	Target (MUo):	1.00 <input checked="" type="checkbox"/> Use homogenised process average as Target		
EWMA	FIR (Steiner's f):	0.50 (0.50)	Control Limit Width, L (in Sigmas):	2.70 (2.70)
			Smoothing Constant (Lamda):	0.10 (0.10)
		<input checked="" type="checkbox"/> Find 'best-fit' Lamda from process data.		

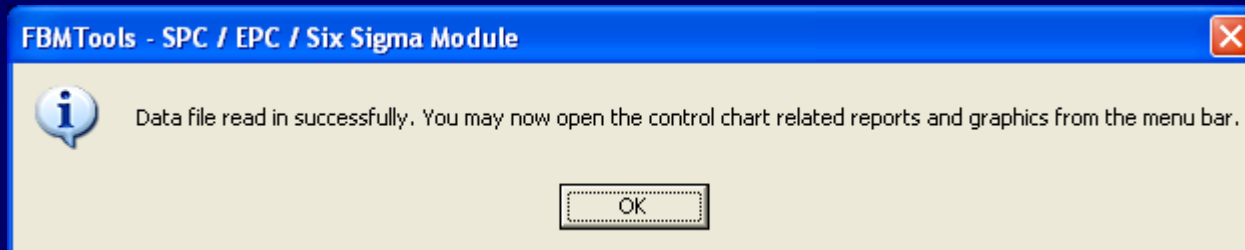
**Option for Control Chart Limits:** Computed from data **START ANALYSIS NOW**

Add New Record    Goto Workbook ID ->    Save / Update    Delete    Refresh    Close

Workbook ID: 2 (Total 2 records)

## Example Project (Manufacturing Industry)

He has then looked at 'SPC Parameters' tab and just made one entry (Target = 1.00) and kept all others at default values. As the basic chart selected was Xbar-S and chart type selected was 'Conventional', these parameters were not required. Regarding 'EPC Parameters' tab, he decided to enter the details at a later stage (after analysing the data using Scatter Plot and Regression tool).



## Example Project (Manufacturing Industry)

He then clicked on the 'START ANALYSIS NOW' button, and received the above message.

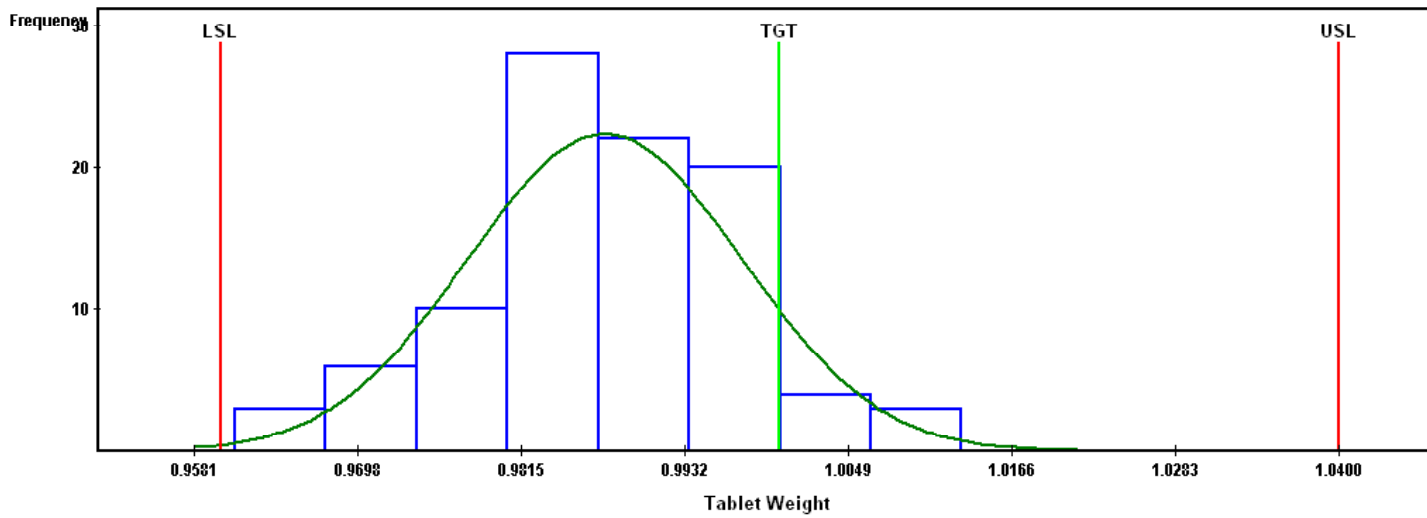
Now, he decided to see the graphs first.

### Tablet Weight Control

(M/c No - 2, Period: 16-17 August 2011)

Characteristic: Tablet Weight (Grams)

#### Histogram



\* Based on un-homogenised data. Mean & SD computed by Frequency Table method.

LSL = 0.9600 TGT = 1.0000 USL = 1.0400 N = 96 Mean = 0.9875 SD = 0.0098

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18-Aug-2011 10:01

**Example Project (Manufacturing Industry)**  
Histogram, depicting the data distribution (spread) viz-a-viz tolerance band (technical specifications).

### Tablet Weight Control

(M/c No - 2, Period: 16-17 August 2011)

Characteristic: Tablet Weight (Grams)

#### Frequency Table

Class	>= LB	< UB	Mid Value	Frequency
1	0.9610	0.9675	0.9643	3
2	0.9675	0.9740	0.9708	6
3	0.9740	0.9805	0.9773	10
4	0.9805	0.9870	0.9838	28
5	0.9870	0.9935	0.9903	22
6	0.9935	1.0000	0.9968	20
7	1.0000	1.0065	1.0033	4
8	1.0065	1.0130	1.0098	3

Mean = 0.9875   Standard Deviation = 0.0098   N = 96

**Example Project (Manufacturing Industry)**  
Frequency Table (optional add-on to Histogram), showing data distribution in tabular form.

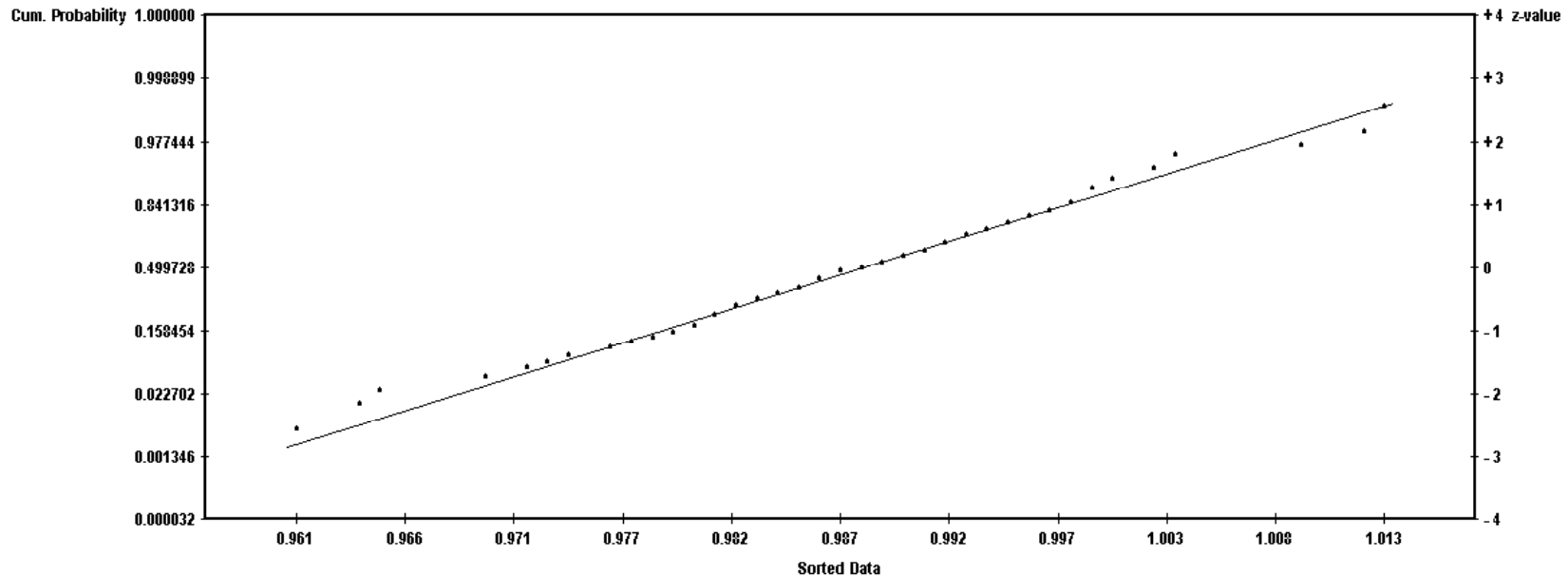


## Tablet Weight Control

(M/c No - 2, Period: 16-17 August 2011)

Characteristic: Tablet Weight (Grams)

## Normal Probability Plot

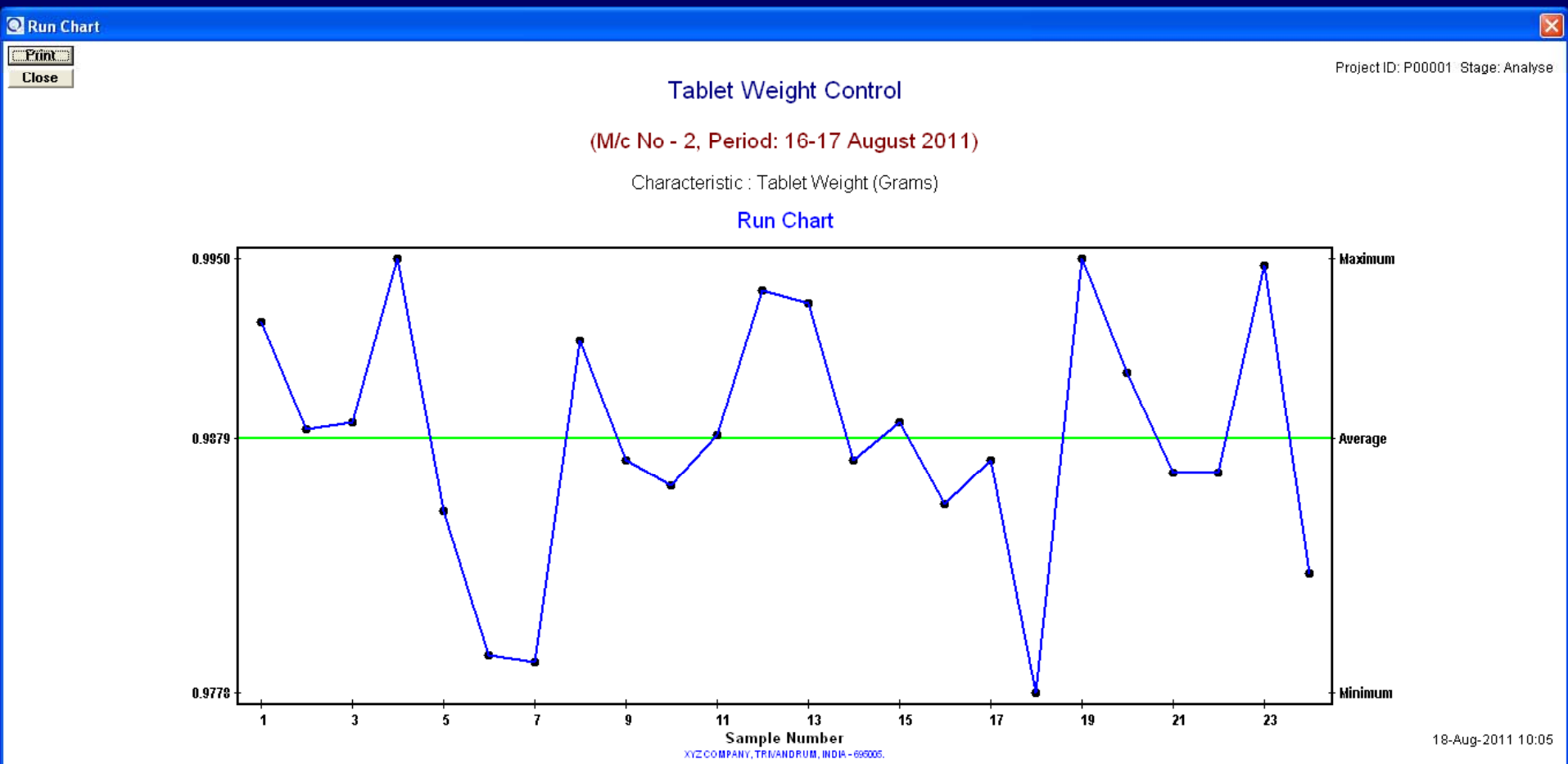


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18-Aug-2011 10:03

## Example Project (Manufacturing Industry)

Normal Probability Plot (NPP) is a very important visual aid for checking the normality of data (i.e., to examine whether the data comes from a population with Normal Distribution). If the data follows Normal Distribution, the plotted points would form a straight line.



**Example Project (Manufacturing Industry)**

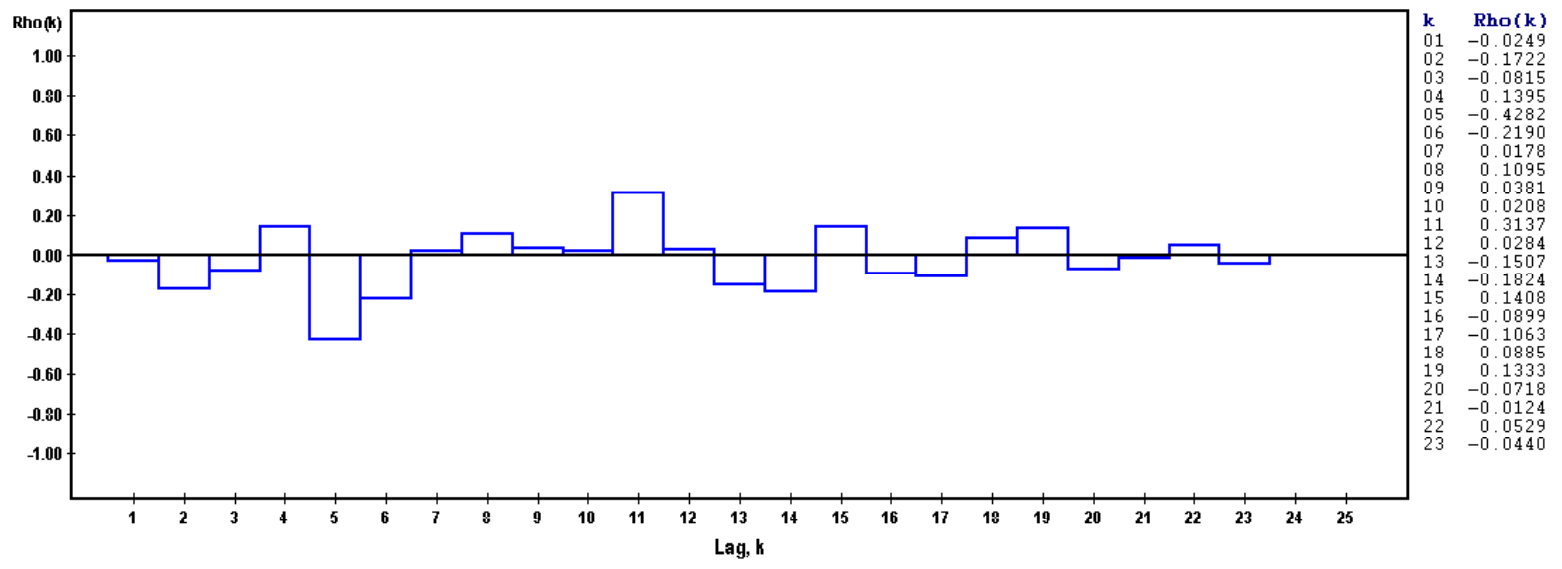
Run chart is a simple plot of sample averages, which gives a visual understanding of patterns and trends in control chart data.

### Tablet Weight Control

(M/c No - 2, Period: 16-17 August 2011)

Characteristic: Tablet Weight (Grams)

#### Auto Correlation Chart



**Example Project (Manufacturing Industry)**

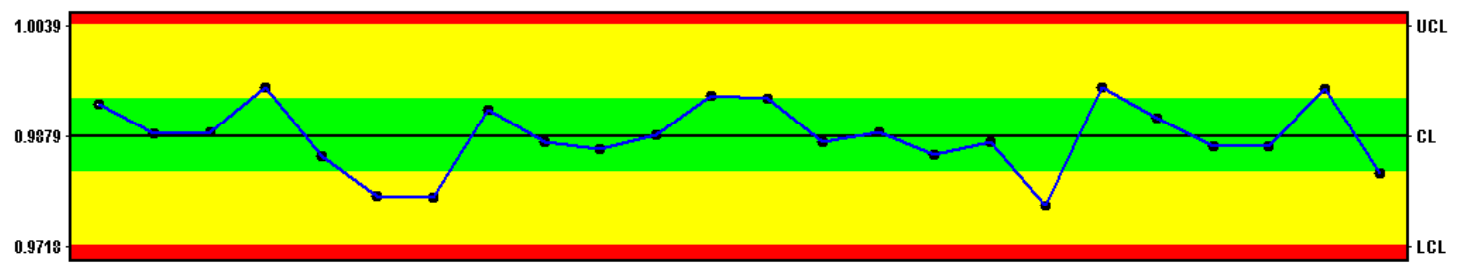
Traditional SPC charts are not effective when the data is highly auto-correlated (i.e., when consecutive data points are correlated). If the bars on the Auto-Correlation Chart are shorter, it indicates less amount of auto-correlation. In case the data is highly auto-correlated, use Un-weighted Batch Mean (UBM) chart.

### Tablet Weight Control

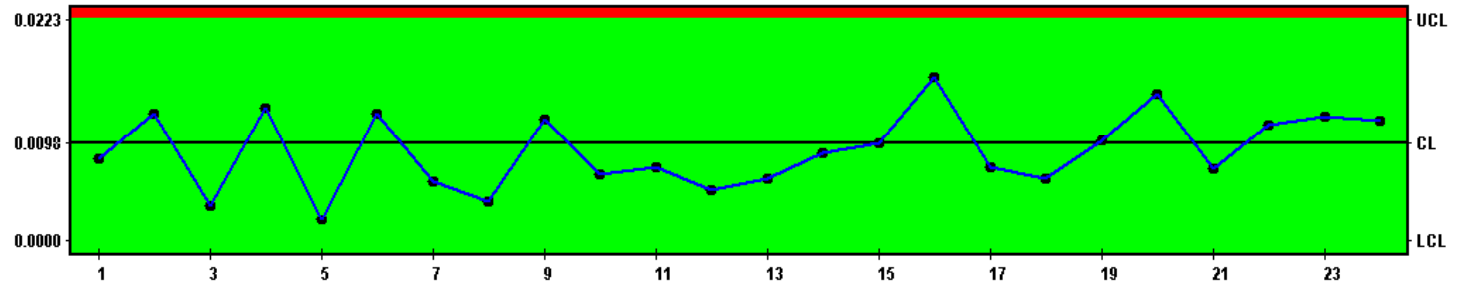
(M/c No - 2, Period: 16-17 August 2011)

Characteristic: Tablet Weight (Grams)

#### Xbar Chart



#### Standard Deviation Chart



## Example Project (Manufacturing Industry)

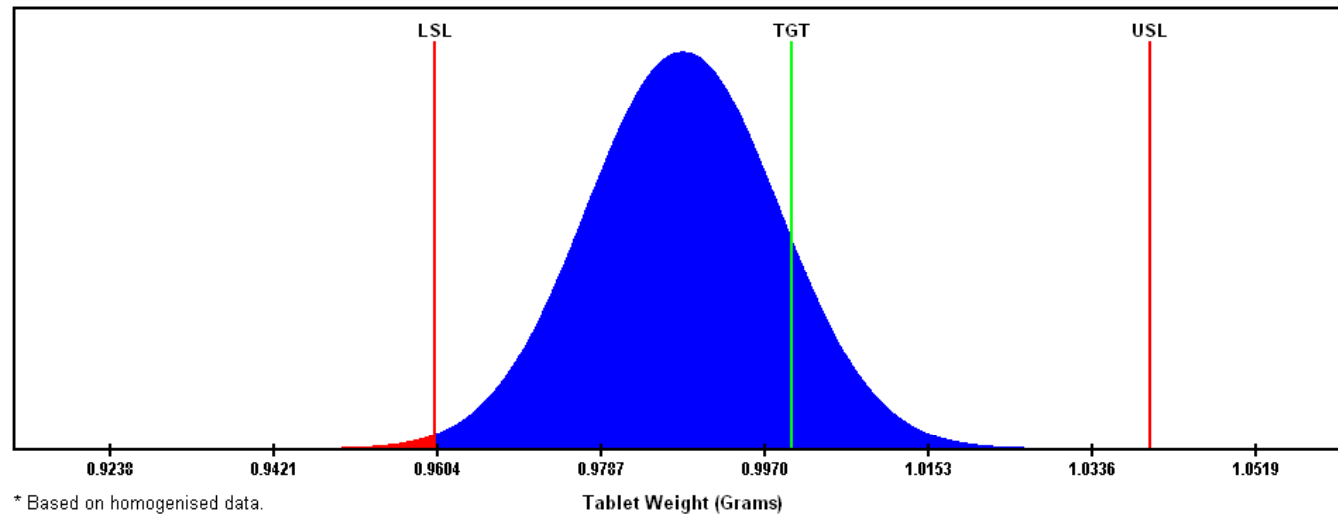
Control chart shows that the process is under statistical control. That means, there is no sporadic (assignable) cause present. The process is stable.

## Tablet Weight Control

(M/c No - 2, Period: 16-17 August 2011)

Characteristic: Tablet Weight (Grams)

## Normal Curve



\* Based on homogenised data.

LSL = 0.9600 TGT = 1.0000 USL = 1.0400 Mean = 0.9879 SD = 0.0107 Cp = 1.25 Cpk = 0.87 Cpm = 0.82 Cpkm = 0.57 Cpc = 0.82

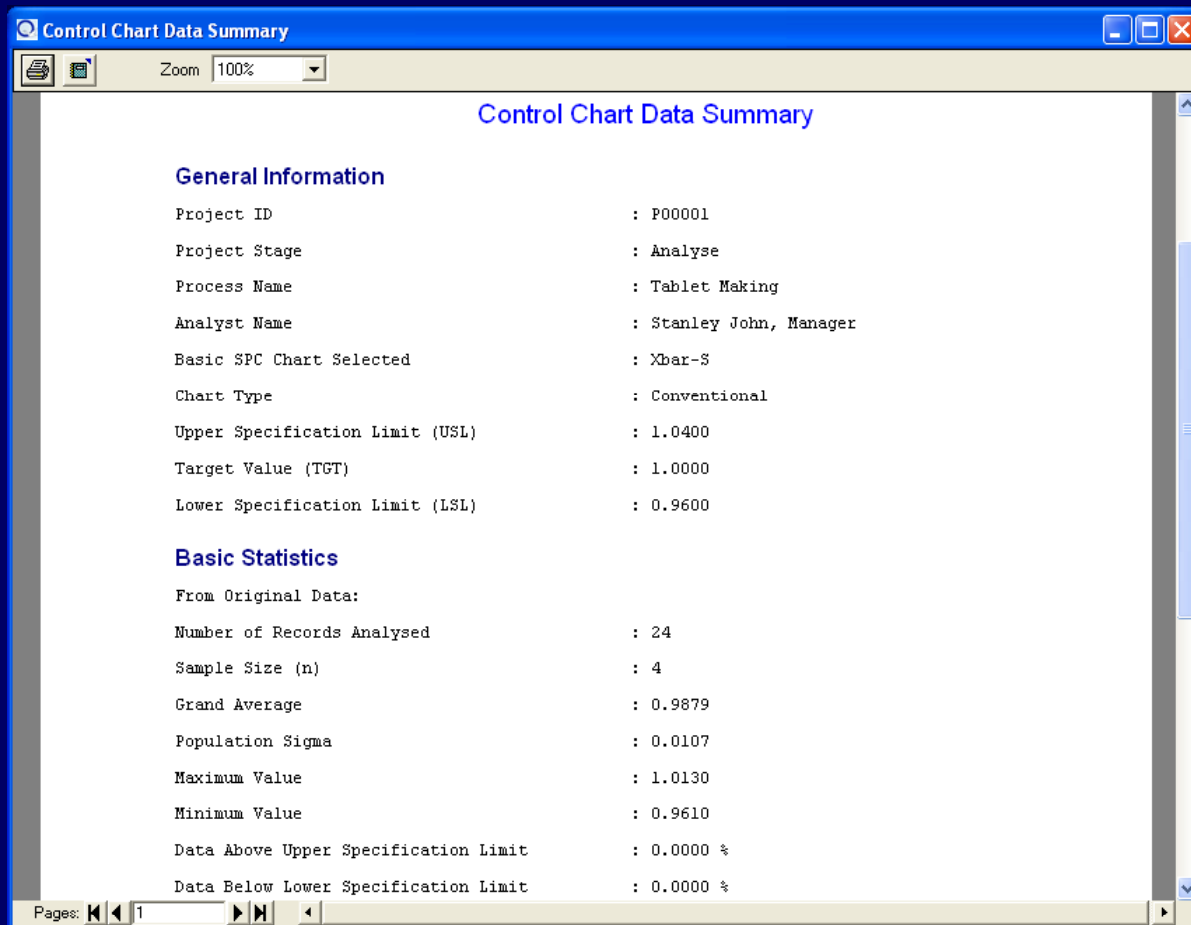
DPM = 4542.0366 Sigma Quality Level = 4.1066 Yield (%) = 99.5458

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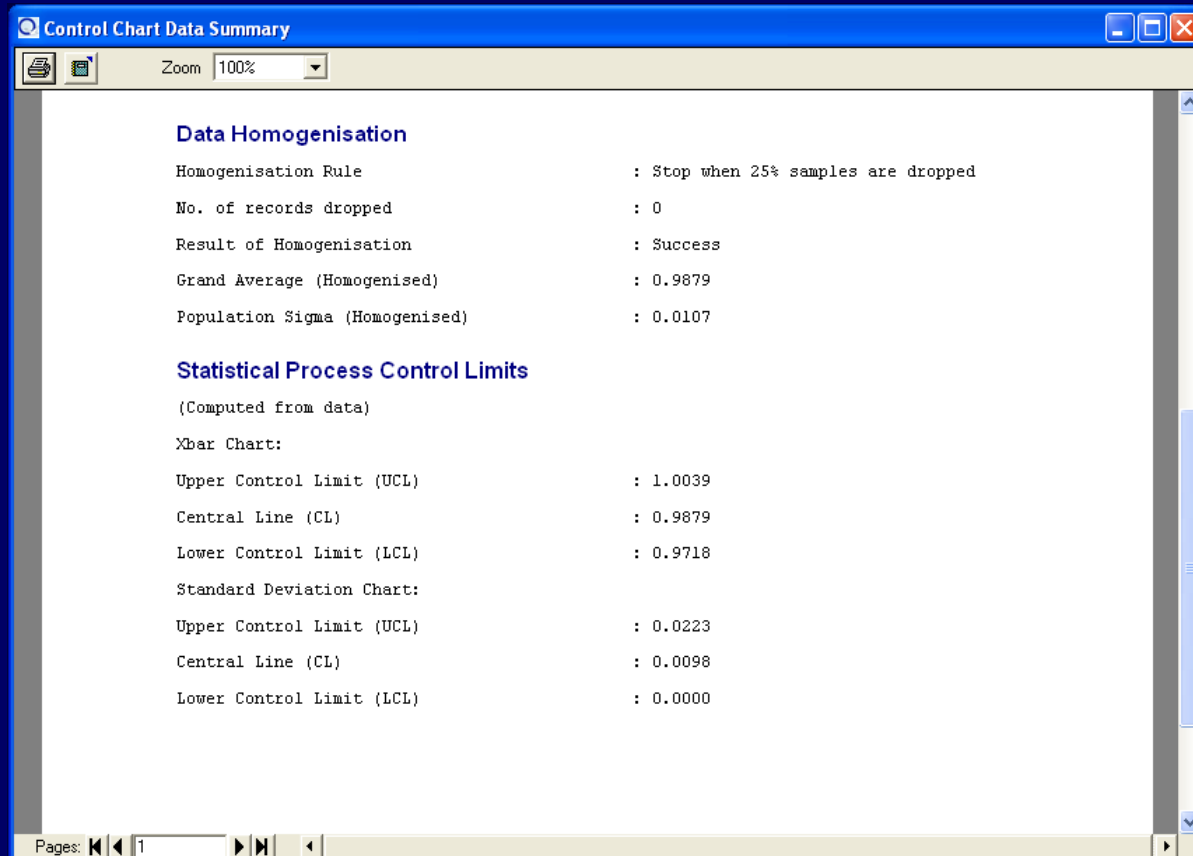
## Example Project (Manufacturing Industry)

Six Sigma Metrics & Probability Distribution (Normal) gives an idea about expected rejections. Though none of the data analysed were beyond specifications, the small red zone below the lower specification limit (LSL) indicates possibility of manufacturing out-of-spec products. Also, the process is barely capable ( $C_p < 1.33$ ) and not centered ( $C_{pk} < 1$ ).



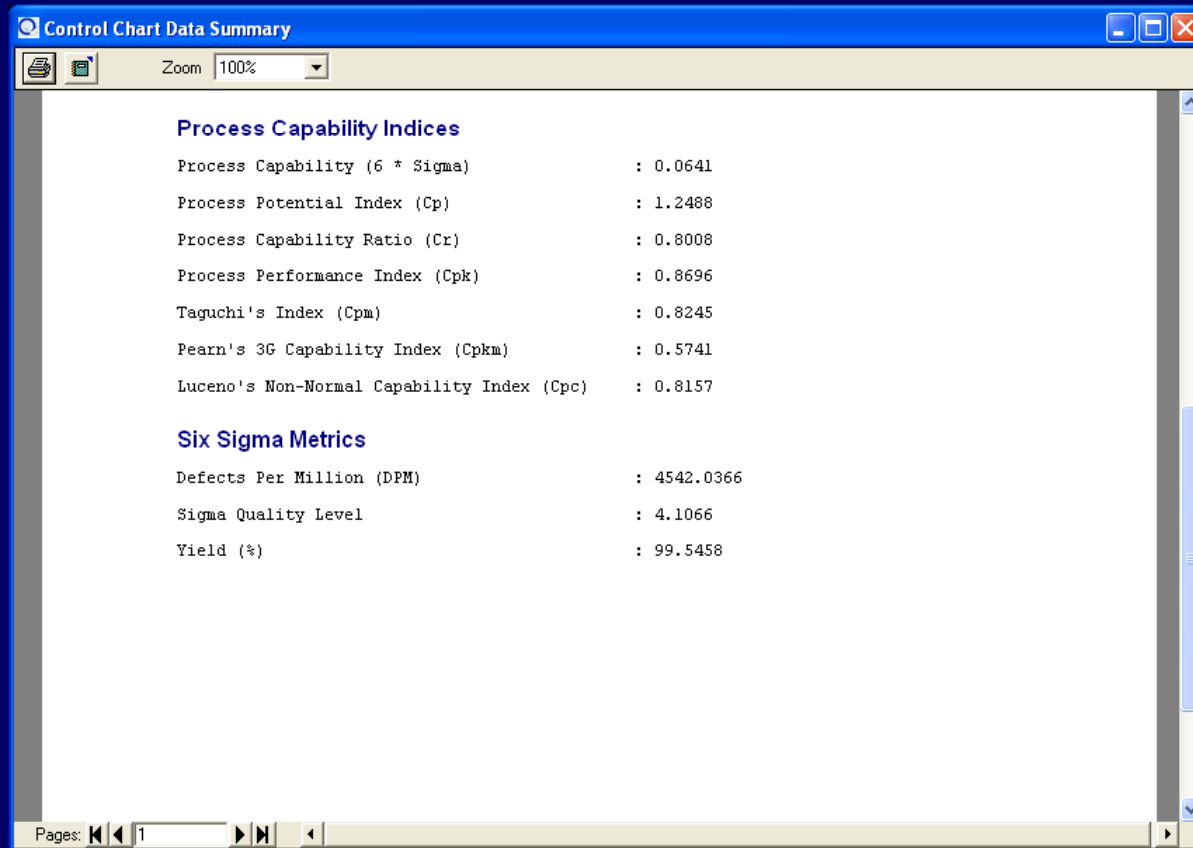
## Example Project (Manufacturing Industry)

Now, the reports were looked at. First, the data summary.



## Example Project (Manufacturing Industry)

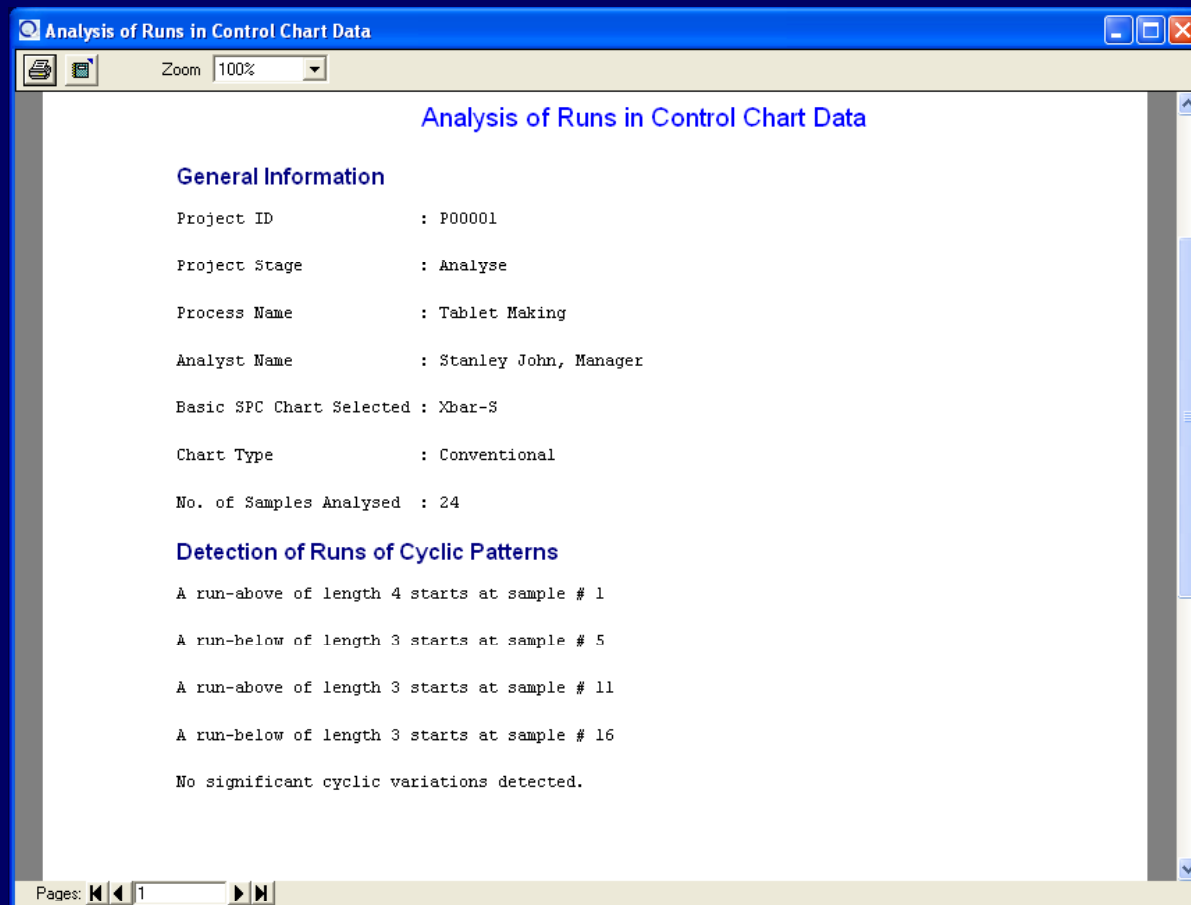
Data summary, continues.



## Example Project (Manufacturing Industry)

Data summary, report ends.





## Example Project (Manufacturing Industry)

Then he looked at the Control Chart Run Analysis, but couldn't see any significant cyclic variations. Mr. John has concluded that the real problem is in process setting. From his technical knowledge, he knows that Tablet Weight can be adjusted by controlling the Feed Rate (input variable). But, he needed to establish the relation, i.e., Average Weight of Tablet (Y) Vs Feed Rate (X). For this, he decided to use scatter plot & linear regression.

**Data Analysis Work Book: Scatter Plot and Linear Regression**

Six Sigma Project ID: P00001 Project Phase: Analyse

Main Title: Tablet Weight Control

SubTitle: (M/c No. 2, Period: 16-17 August 2011)

Data File: tablet\_weight.xls Browse View Datafile

Independent Variable (X): Feed Rate Unit Kg/s Data Column 8

Dependent Variable (Y): Avg. Tablet Weight Unit Grams Data Column 7

Data Rows: From 1 To 24  Show Regression Line  Show Equation  
Decimal places in output: 4 <- 1 to 9

General Notes:

Name of Process:

Name of Analyst:

**START ANALYSIS NOW**

Add New Record Goto Workbook ID -> Save / Update Delete Refresh Close

Workbook ID: 1 (Total 1 records)

## Example Project (Manufacturing Industry)

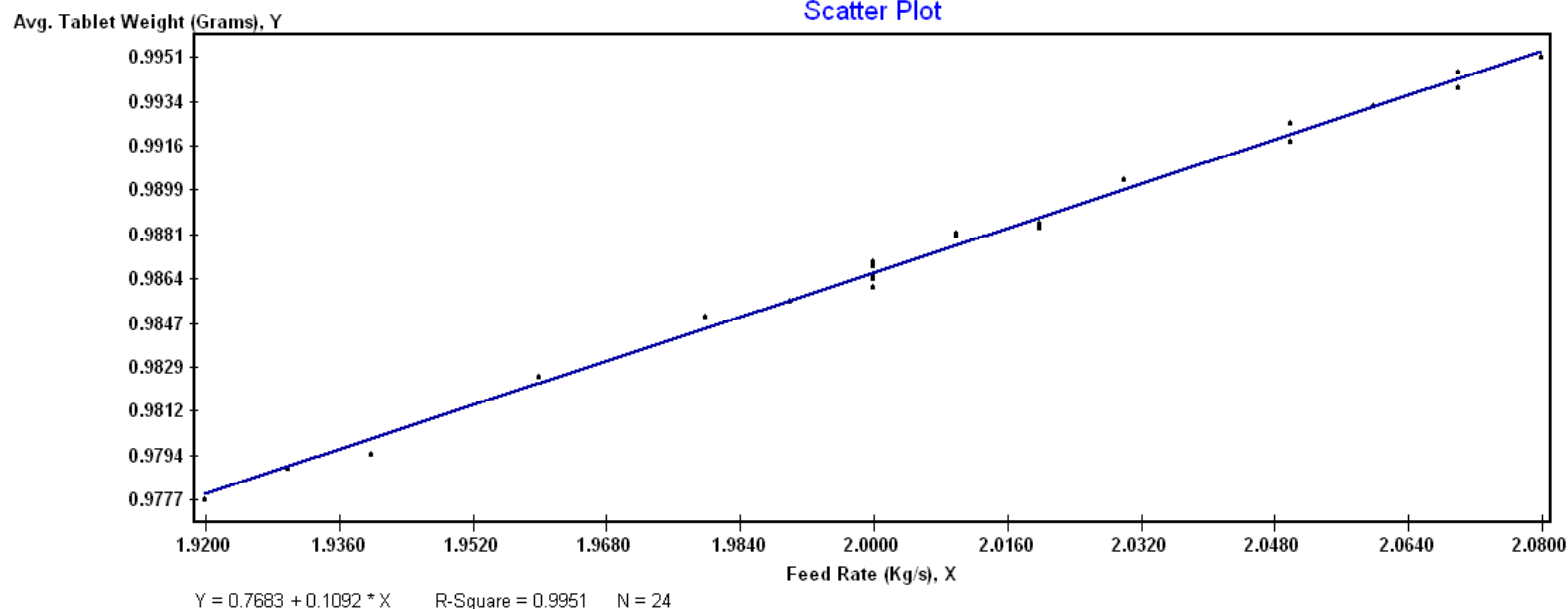
Then he created a Scatter Plot workbook.

## Tablet Weight Control

(M/c No. 2, Period: 16-17 August 2011)

Avg. Tablet Weight (Y) Vs Feed Rate (X)

## Scatter Plot



## Example Project (Manufacturing Industry)

By clicking on the 'START ANALYSIS NOW' button, he could see the scatter plot & regression line. As a rule of thumb, R-square value must be at least 0.70 for the regression line to be considered as meaningful. Mr. John looked at the R-square value. It was 0.9951 (very close to the perfect value). So, he decided to use the equation.

## Example Project (Manufacturing Industry)

### Setting up an Engineering Process Control (EPC) chart for the Tablet making process:

It involved the following steps (and cues from the User Manual accompanying the SPC software):

1. Selection of feedback control model: Selected **Integral** model, for simplicity.
2. Setting the parameter (g) for the selected model: Overall Process Gain, **g = 0.1092**
3. Setting the Smoothing Constant ( $\lambda$ ) for EWMA predictor:  **$\lambda = 0.15$**  ('best fit' from recent data)
4. Setting the Adjustment Boundary Value (L) for EWMA predictor: **L = 0.0041**
5. Re-setting the process average at the Target value (1.00 gram): Done by engineering means.
6. Installing an EPC chart and monitoring (and adjusting) the process: For this, he went back to the SPC software.

Let's see what he did there.

**Data Analysis Work Book: SPC Charts and Histogram**

Six Sigma Project ID: P00001 Project Phase: Analyse

Analysis Title: Tablet Weight Control

SubTitle: (M/c No - 2, Period: 16-17 August 2011)

Characteristic (Y): Tablet Weight Measurement Unit: Grams

Basic SPC Chart: Xbar-S Chart Type: Conventional

Homogenisation Rule: Stop when 25% samples are dropped  Draw control charts with colour bands

**EPC Parameters**

Perform Engineering Process Control (EPC) computations

Name of Input Variable (X): Feed Rate UOM: Kgs / Second

Feedback Control Model: Integral

Overall Gain (g): 0.1092 <- This is the change in output variable (Y) for unit increment in input variable (X)

Proportional Gain (Kp): Integral Gain (Ki): Derivative Gain (Kd):

Process Target (T): 1 EPC Smoothing Constant (Lamda): .15

Adjustment Boundary Value (L): 0.0041  Find 'best-fit' Lamda from process data.

Option for Control Chart Limits: Computed from data **START ANALYSIS NOW**

Add New Record Goto Workbook ID -> Save / Update Delete Refresh Close

Workbook ID: 2 (Total 2 records)

## Example Project (Manufacturing Industry)

Mr. John has edited the original control chart workbook (EPC Parameters tab), as above.

tablet_weight.fts									
Row No	Col 001	Col 002	Col 003	Col 004	Col 005	Col 006	Col 007	Col 008	
20	17-Aug-2011	01.00 Hrs	0.978	0.979	0.996	1.009	0.9903	2.03	
21	17-Aug-2011	02.00 Hrs	0.981	0.982	0.997	0.986	0.9865	2.00	
22	17-Aug-2011	03.00 Hrs	0.981	0.976	0.986	1.003	0.9864	2.00	
23	17-Aug-2011	04.00 Hrs	1.012	0.983	0.995	0.989	0.9945	2.07	
24	17-Aug-2011	05.00 Hrs	0.990	0.984	0.991	0.965	0.9825	1.96	
25									
26	After process re-set								
27									
28	18-Aug-2011	14.00 Hrs	1.000	1.008	1.012	0.988	1.0020	2.13	
29	18-Aug-2011	15.00 Hrs	0.991	0.995	1.017	1.001	1.0010	2.13	
30	18-Aug-2011	16.00 Hrs	1.007	1.013	0.999	0.982	1.0004	2.13	
31	18-Aug-2011	17.00 Hrs	1.001	0.992	1.000	0.987	0.9947	2.13	
32	18-Aug-2011	18.00 Hrs	1.005	1.002	1.012	0.998	1.0041	2.13	
33	18-Aug-2011	19.00 Hrs	0.990	0.998	1.006	0.994	0.9971	2.13	
34									
35									
36									
37									
38									
39									
40									
41									
42									
43									
44									
45									
46									
47									

Record: 1 \*\*\*\* Please do not edit row numbers. Software manages it by itself. \*\*\*\*

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## Example Project (Manufacturing Industry)

After process re-set, fresh data were taken from 2.00 PM onwards and entered in the same data file as above.

**Data Analysis Work Book: SPC Charts and Histogram**

Six Sigma Project ID: P00001 Project Phase: Control

Analysis Title: Tablet Weight Control

SubTitle: (M/c No - 2, Period: From 18 Aug 2011)

Characteristic (Y): Tablet Weight Measurement Unit: Grams

Basic SPC Chart: Xbar-S Chart Type: Conventional

Homogenisation Rule: Stop when 25% samples are dropped  Draw control charts with colour bands

**Data Input** Specifications SPC Parameters EPC Parameters Process Info.

Data File: tablet\_weight.fts Browse View Datafile

Data Columns: From 3 To 6

Data Rows: From 28 To 33

Sample Size Column:  <- for p, np, and u charts only.

Nominal Value Column:  <- for short run chart type only.

Decimal places required in numeric output: 4 <- between 0 and 9 only.

Option for Control Chart Limits: Computed from data **START ANALYSIS NOW**

Add New Record Goto Workbook ID ->  Save / Update Delete Refresh Close

Workbook ID: 2 (Total 2 records)

## Example Project (Manufacturing Industry)

Then, the work book entries were modified (such as project phase changed to 'Control', etc) as above.

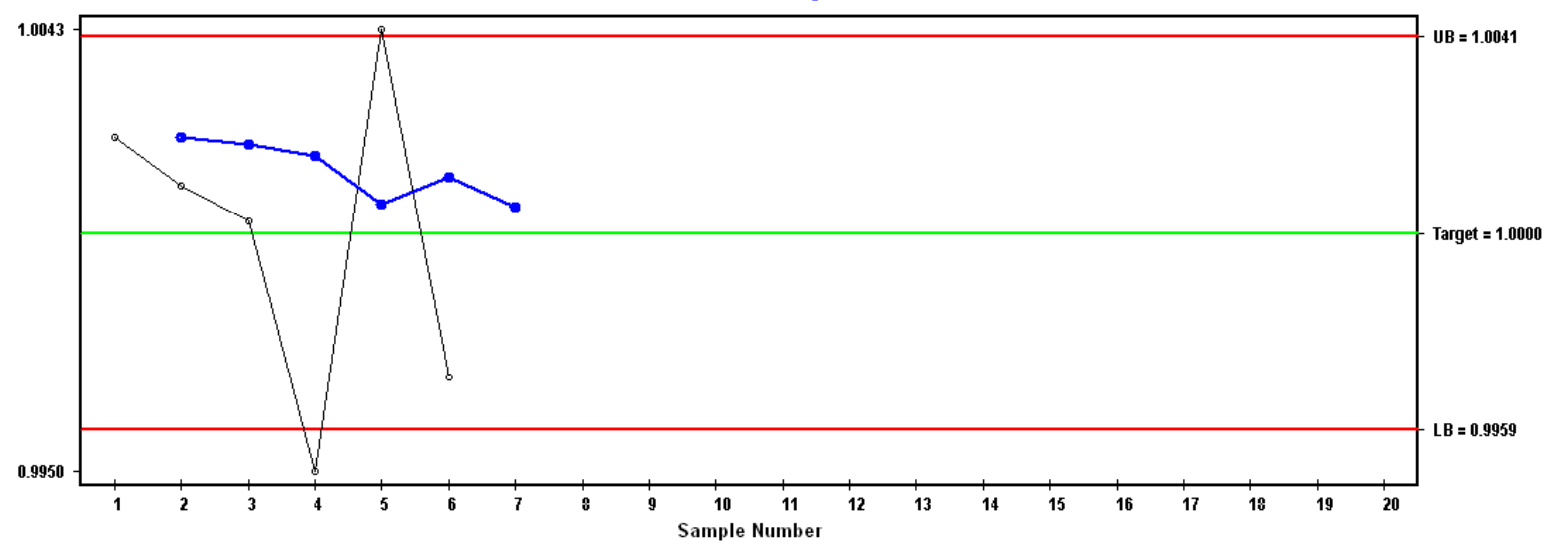
### Tablet Weight Control

(M/c No - 2, Period: From 18 Aug 2011)

Characteristic (Y): Tablet Weight (Grams)

### Engineering Process Control Chart

Control Model: Integral



Lamda = 0.1500 Gain (g) = 0.1092 Target = 1.0000

Next Point Prediction = 1.0005 Control Action: Leave Feed Rate (X) at its present level.

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## Example Project (Manufacturing Industry)

Then hit the 'START ANALYSIS NOW' button, and checked the EPC chart ('Graphics' menu).

The thin graph in black colour is the sample mean. The thick graph in blue colour is the EWMA predictor for process average. The next point prediction (predicted value for process average at 8.00 PM) was 1.0005 and the advice was to leave the Feed Rate (X) at its present level (i.e., 2.13).



We have discussed two practical projects so far.

What are you thinking now ?

**Never thought that such things could be done in your organisation also !**

As they say, it is better late than never.

Our software could be a helpful companion in your improvement initiatives.

This product is available in three editions (Academic / Lite / Standard).

Each edition is designed to serve a particular user category.

Let us now talk about the software features in detail.

FBM Tools -SPC / EPC / Six Sigma : Login

Welcome To  
**FBM Tools - SPC / EPC / Six Sigma Module**

User ID: stanley  
Please select your User ID from the list

Password: \*  
Password is case sensitive

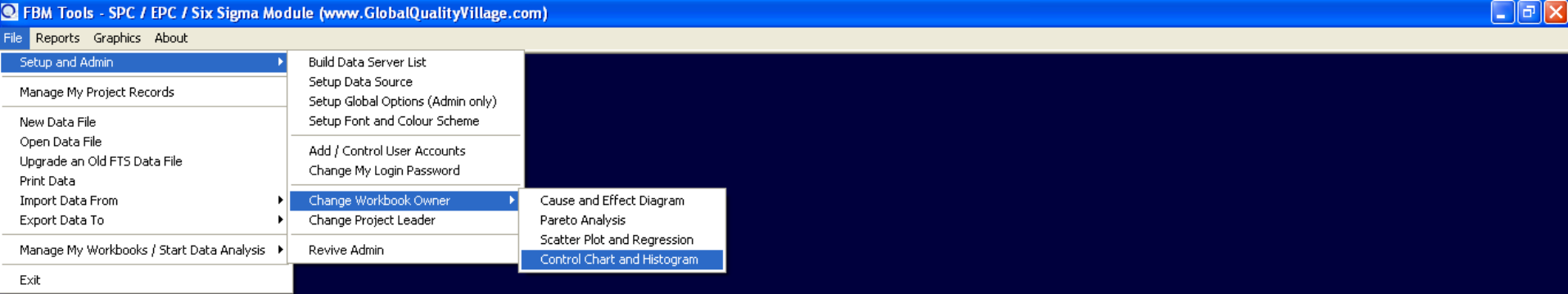
Login As:  User  Admin

OK Cancel

This is the login screen.

Select your User ID from the list, enter the password, and select a login option (User / Admin).

Then press 'OK' to enter the software.



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The major menu items are: File, Reports, Graphics, and, About.

Under the **File** menu, users can create six sigma project records, create / edit data files in this software's own format, import data from MS-Access / Excel / Text files (also export data to these file formats), create workbook records, and, analyse data through these menu items.

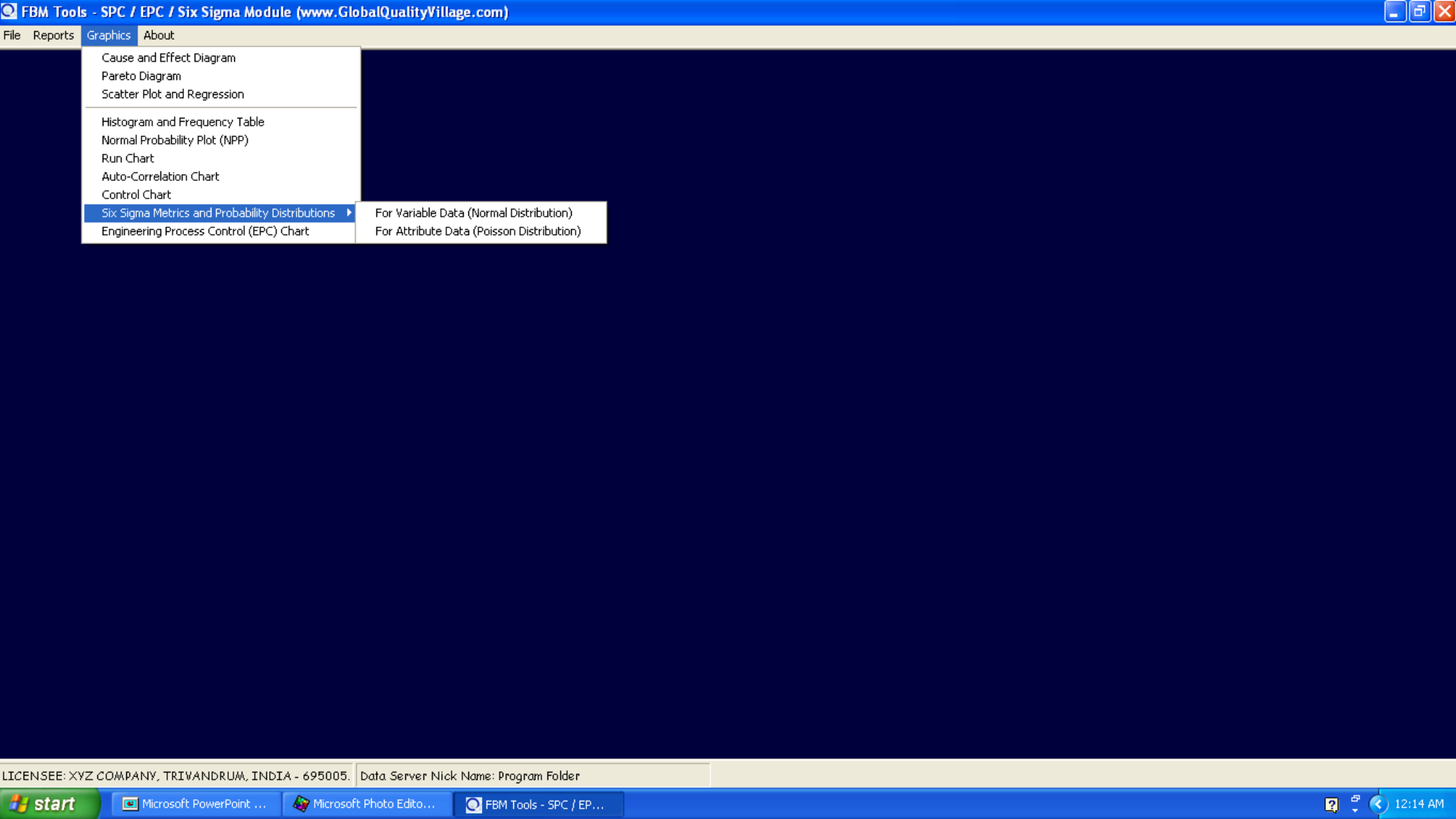
System Administrator can access various admin and set-up menu items.



**Reports** menu generates reports in text form, which can be printed or saved as PDF files.

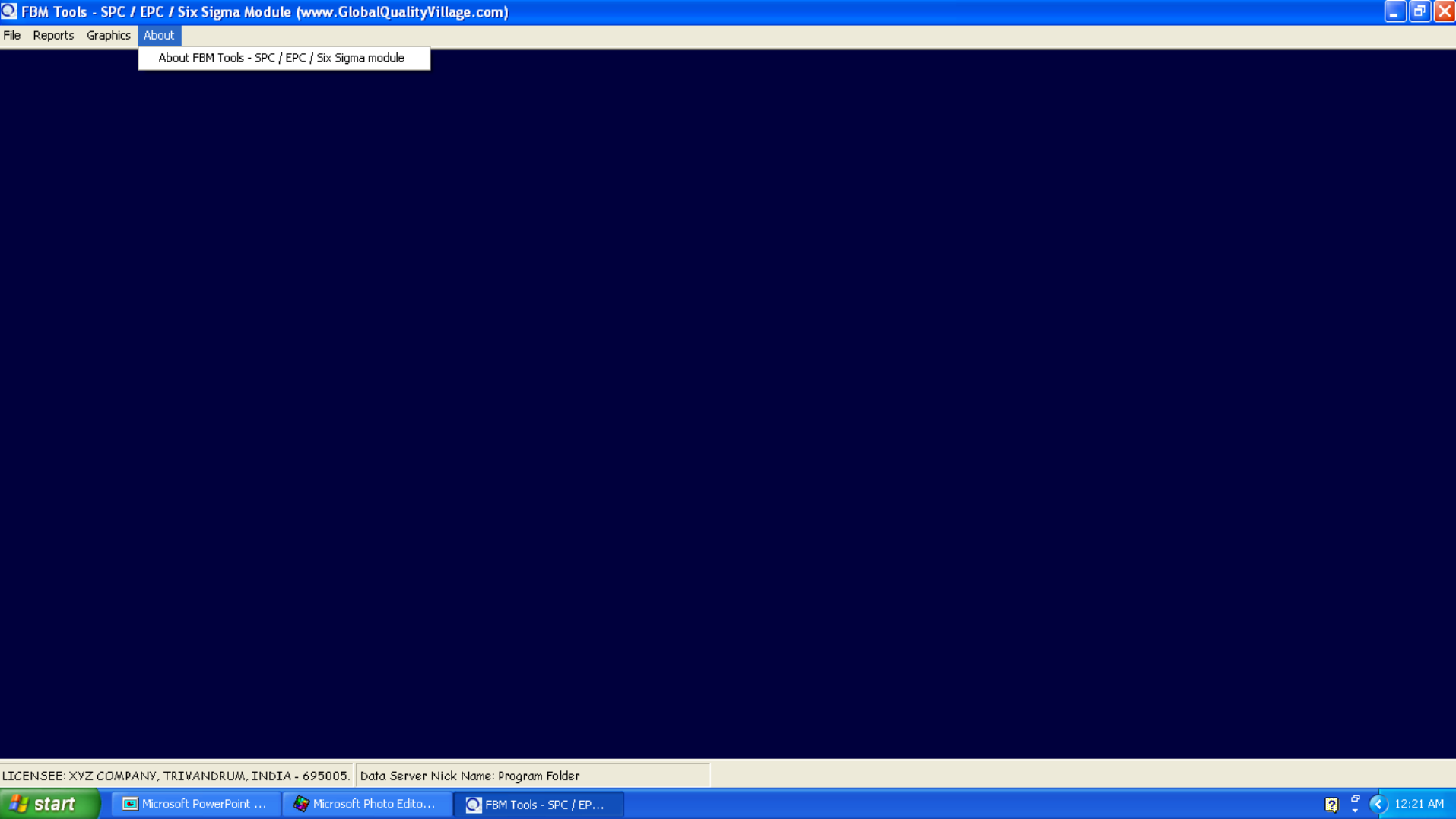
Project and workbook related queries can be made here. There are many data filters which helps in segregating only those records (related to projects you are involved in and workbook records created by you) that you wish to view during your Six Sigma projects.

Control chart data summary and run analysis reports can also be generated through this menu.



**Graphics** menu is the heart of this software. You can view/print graphs, or save them as PDF files. Cause & Effect Diagram, Pareto Diagram, and, Scatter Plot are very important tools required for most of the Six Sigma projects.

The rest of the graphical output relates to SPC control charts. Advanced users can generate EPC prediction chart also.



**About** menu tells about the software edition, product tracking number, contact address for technical support, etc.

Let us now look at more details of this software.

## Basic SPC Charts Supported:

Name of chart	Data	Typical areas of application
X - Moving Range	1 data / sample	Chemical processes
Xbar - Range	2 - 5 data / sample	Turning operation
Xbar - SD	2 - 200 data / sample	Blanking process
Fraction Defective (p)	sample size $\geq 1$	Visual inspection (good/bad) of lot items
Nos. Defective (np)	sample size $\geq 1$	Visual inspection (good/bad) of lot items
Defects / Item (c)	sample size = 1	Visual defects (count) of castings
Defects / Unit (u)	sample size $> 0$	Clerical mistakes (count) in data entry

## Advanced SPC Charts Supported:

Name of chart	Data	Typical areas of application
Short run / Standardized	Same as basic charts	For job-shop (small lot production)
Slopping / Tool wear	2 - 200 data / sample	Where gradual process shift is inherent
Six Sigma Process	2 - 200 data / sample	For monitoring Six Sigma processes
Coefficient of variation (CV)%	2 - 200 data / sample	Normally, in textile and jute processing
Moving Avg. - Moving Range	1 data / sample	When data is slightly auto-correlated
Moving Avg. - Moving SD	1 data / sample	When data is slightly auto-correlated
CuSum	1 - 200 data / sample	To detect small shifts in process mean
EWMA	1 - 200 data / sample	To detect small shifts in process mean
UBM	1 data / sample	When data is highly auto-correlated



## Other Tools Supported:

Name of Tool	Typical use
Cause and Effect Diagram	Brainstorming (cause-effect mapping)
Pareto Diagram	Finding the vital few defects / problems
Scatter Plot and Linear Regression	To study x-y relation between variables
Histogram and Frequency Table	To visualize spread (variability) in data
Normal Probability Plot (NPP)	To check normality of data
Auto-Correlation Chart	To check auto-correlation in data
Run Chart	To visualize trends in process mean
Normal Curve	To visualize variability Vs specifications
Poisson Distribution	To visualize defect data distribution

## Statistical Analysis and Computations:

- Summary statistics
- Run analysis (detection of cyclic variations)
- Process capability indices - Cp, Cpk, Cpm, Cpkm, Cpc (for non-normal data)
- Six Sigma metrics - Defects Per Million, Sigma Quality Level, Yield %

## Engineering Process Control (EPC):

- Supports Integral, Proportional-Integral, and, Proportional-Integral-Derivative (PID) control models
- Draws EPC prediction chart
- Performs process adjustment calculations

## Optional Control Chart Features:

- Can draw control charts with lines or colour zones
- Can also draw charts with user-defined limits (process monitoring mode)
- Homogenizes data with user-selected cut-off %

## General Features:

- Can import data from Access / Excel / Text files
- Can export data to Access / Excel / Text files
- Supports workgroups & project management
- Includes a detailed user manual (in pdf)
- Includes sample data files for every tool
- Provision for FREE / paid user training on software operations (at our training facility in Kerala)
- Provision for SPC / EPC / Six Sigma training (in Kerala) & e-Consultancy at extra cost.

## OS & Recommended Minimum Hardware:

- Operating System : Windows XP or later editions
- Computer : PC / Laptop
- CPU speed : 1 GHz
- RAM : 1 GB
- Hard Disk : 2 GB free disk space
- Screen : Color monitor with 1024 x 768 resolution or higher
- Printer : Color Inkjet / Laser printer

## Edition-wise Comparison:

This software comes in two forms, namely, **LITE** Edition (multi-user) and **STANDARD** Edition (multi-user) to suit the varying requirements of prospective buyers.

We highly recommend STANDARD edition for corporate users, and, LITE edition for small businesses and academic users (professors teaching SPC / Six Sigma, executives preparing for Six Sigma Green Belt / Black belt examination, etc.).

Both editions are economically priced, making them very affordable to corporate bodies as well as individuals.

<b>Particulars</b>	<b>Lite Edition</b>	<b>Standard Edition</b>
Target user segment	SMEs, Teachers, Students	Large Companies
Max. records (rows) / analysis	100	10000
Max. No. of data columns	50	200
Max. No. of Users / Site License	5	Unlimited
Product warranty & support	3 months	6 months
User training in Kerala (India)	For nominal fee	FREE for 1 person
No. of FREE upgrades	2	3
Migration to Standard Edition	Allowed	Not required

Thank you for the patience. Please see the CD pricing.

Best Value  
for  
Money

**STANDARD Edition** (Product code: S0003B) of this software is priced **US\$ 199** (Indian Rupees 11400) only per site license.

Note: One **site license** of **Standard** edition allows unlimited number of users at buyer's one site (premises). This offer includes product support for six (6) months, 8-hours of hands-on training for one user at our training facility in Kerala (India), and **THREE** major upgrades (i.e., version 7.xx to version 10.xx).

**LITE Edition** (Product Code: S0002B) of this software costs **US\$ 130** (Indian Rupees 7400) only per site license.

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