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Statistical Process Control in Coordinate-Measuring Machine

Dinesh G, Dr. S. V. Suresh Babu, M.E., Ph.D.,

Student, Dept. of Mechanical Engineering, Adhiyamaan College of Engineering, Dr. MGR Nagar, Hosur, Tamil Nadu, India

Professor & Head, Department of Mechanical Engineering, Adhiyamaan College of Engineering, Dr. MGR Nagar, Hosur, Tamil Nadu, India

ABSTRACT: To analyze the measurements, accuracy and deviations of the output of the Three Coordinate measuring machines against a given set of values using a method called Statistical Process Control (SPC). The analysis can be made against a single unit or a collection of units in a daily or weekly or monthly or yearly basis. The result can help us in achieving accuracy of the produced product, reduce the scrap output and compare variations or dispersion across various timelines of the produced output.

KEYWORDS: Statistical process control, Control charts.

I. INTRODUCTION

Statistical Process Control is a technique that uses statistical methods to monitor data from a manufacturing process. There are two types of data one is attribute and another one is variable, SPC can be applied to any process where the "conforming product" output can be measured. In the emerging total quality environment, a fundamental understanding of all process is essential for continuous improvement

IMPLEMENTING OF STATISTICAL PROCESS CONTROL

Before implementing SPC or any new quality system, the manufacturing process should be evaluated to determine the large amount of waste in area, some type of manufacturing process waste are rework, scrap and excessive inspection time. It would be most favourable to apply the tools of SPC to these areas. In SPC, not all measurements are monitored due to the expense, time and production delays that would incur.

COORDINATE-MEASURING MACHINE

A coordinate measuring machine (CMM) is a device that uses a probe to detect specific point on the objects surface and measure their geometrical shapes. Different types of probes are used in CMMs, including mechanical, laser, ocular, and white light. In CMM probe positioning are two types they are manually controlled and automatic, it has been found that the CMMs generally specify a probe's position in terms of its displacement from a comment on position in a Cartesian three-dimensional coordinate system. In addition to moving the probe along the three axes, some machines also allow the probe angle to be controlled to allow measurement of surfaces that would otherwise be unavailable.

TOOLS FOR SPC

- Check sheet
- Run chart
- Histogram
- Pareto chart
- Scatter diagram/chart
- Cause and effect or fishbone diagram
- Control chart

CONTROL CHART

In statistic technique, Control chart is the tool in control processes to determine whether a manufacturing process is in a controlled statistical state. This chart is a graph which is used to study the process changes over time.

It is bound to have a central line of average, a top line consists upper control limit and a bottom line consists lower control limit. Other then, the data get from the process can also be applied in making predictions of upcoming production of the process.

II. METHODOLOGY

The methodology is a general framework used in research work and addresses a data in date wise, it was analyse the error and find the next defect time with help of statistical technique, it also analysis the wide data. The data was collected from coordinate measuring machine after it analyse in statistically. It consists actual, nominal and deviation values, standard deviation is measure the variation and help to value tends to be close to the mean. Choosing of these method because it was very easy, compare to other and it reduce the time highly.

III. EXPERIMENTAL RESULTS

Images shows the results of work, Image (a) is the “output of the CMM” it is the input data of statistical process. Figure(b) shows the “result” of the given data it include lower specification limit and upper specification limit, and also give mean, actual and deviations of the products . (c) Is the “console-new” page it was copy and store the result in day wise its store date order wise its helps to audit. (d) Is the “Index-Metrix” page its shows product details and critical to quality and non-critical to quality. Image (e) is the represent ate the console report with help of control chart. And (f) is the Histogram representation of CMM Console Report.

Calypso Measuring Result					
Measurement Plan	8255	Date	#####	Order	SHOP V
Drawing No.	C636903	Time	07:37:53	Part No.	D 566
Operator	Master	CMM			
Characteristic	Actual	Nominal	Upper Tol	Lower To	Deviation
14 Flatness1	0.065682	0	0.05	0	0.065682
15 X PD-1	0	0	0.04	-0.04	0
16 Y PD-1	0	0	0.04	-0.04	0
17 Dia_PD-1	18.00078	18	0.018	0	0.0007798
18 X Value MILL	0	0	0.04	-0.04	0
19 Y Value MILL	421.9974	422	0.04	-0.04	-0.0026365
20 Diameter_PD-2	18.00324	18	0.1	-0.1	0.0032355
21 X Value_FACE-A	-41.0251	-41	0.2	-0.2	-0.0251218
22 X Value_FACING	-41.0103	-41	0.2	-0.2	-0.0102557
23 X Value_C	-41.038	-41	0.2	-0.2	-0.0379842
24 X Value_CD	-4.04444	-4	0.2	-0.2	-0.0444383
25 X Value-E	-14.038	-14	0.2	-0.2	-0.0379908
26 X Value MILL	-9.06909	-9	0.2	-0.2	-0.0690873
27 X ValueD DRILL	-9.0574	-9	0.2	-0.2	-0.0574012
28 X Value_A-FE	9.860319	10	0.2	-0.2	-0.1396811
29 MILL A FACE	9.876584	10	0.2	-0.2	-0.1234156
30 X Value_FACE-A-BE	9.84994	10	0.2	-0.2	-0.1499606

(a)

J	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
227	Sn	Opn No	LA No.	Description	SCMM Characteristics	Mean	USL	LSL	Date	Ref.No	Actual	Deviation	Status	Weeknum	BoxPlot	Unique no	Week Qty	S
228	1	40	8255	Finish milling	X Value_FACE-A	41	41.2	40.8	#####	D 566	41.025	0.025	5	15	Yes	30	2	
229	2	40	8255	Finish milling	X Value_SF NEAR - B	41	41.2	40.8	#####	D 566	41.010	0.010	5	15	Yes	30	2	
230	3	40	8255	Finish milling	X Value_SF NEAR - C	41	41.2	40.8	#####	D 566	41.038	0.038	5	15	Yes	30	2	
231	4	40	8255	Finish milling	X Value_FACE-C	4	4.2	3.8	#####	D 566	4.044	0.044	5	15	Yes	30	2	
232	5	40	8255	Finish milling	X Value_FACE-E	14	14.2	13.8	#####	D 566	14.038	0.038	5	15	Yes	30	2	
233	6	40	8255	Finish milling	X Value_FACE-D-FE	9	9.2	8.8	#####	D 566	9.069	0.069	5	15	Yes	30	2	
234	7	40	8255	Finish milling	X Value_FACE-D-RE	9	9.2	8.8	#####	D 566	9.057	0.057	5	15	Yes	30	2	
235	8	40	8255	Finish milling	X Value_FACE-A-FE	10	10.2	9.8	#####	D 566	9.860	-0.140	5	15	Yes	30	2	
236	9	40	8255	Finish milling	X Value_FACE-A-MID	10	10.2	9.8	#####	D 566	9.877	-0.123	5	15	Yes	30	2	
237	10	40	8255	Finish milling	X Value_FACE-A-RE	10	10.2	9.8	#####	D 566	9.860	-0.140	5	15	Yes	30	2	
238	11	40	8255	Finish milling	X Value_HEAD FACE- FE	17.5	17.7	17.3	#####	D 566	17.361	-0.139	5	15	Yes	30	2	
239	12	40	8255	Finish milling	X Value_HEAD FACE-MID	17.5	17.7	17.3	#####	D 566	17.360	-0.140	5	15	Yes	30	2	
240	13	40	8255	Finish milling	X Value_HEAD FACE-RE	17.5	17.7	17.3	#####	D 566	17.320	-0.180	5	15	Yes	30	2	
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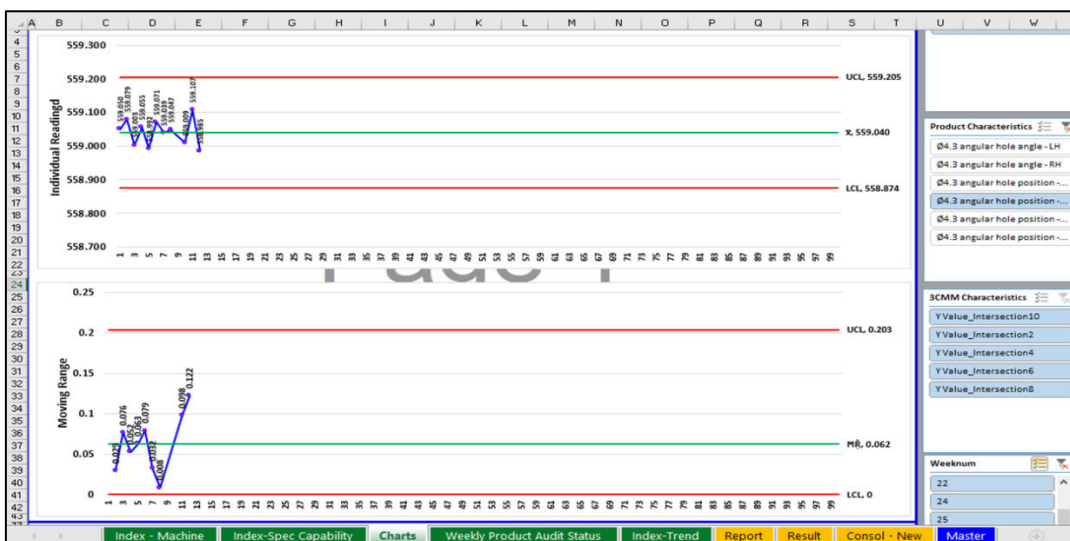
(b)

Sn	Opn N	LA No	Description	USL	LSL	Date	Ref. N	Actual	Deviation	Status	Weeknu	Unique n	Week Ql
1	40	8255	Finish milling	41.200	40.800	09-Apr-21	D 622	41.025	0.025	S	15	30	2
2	40	8255	Finish milling	41.200	40.800	09-Apr-21	D 622	41.010	0.010	S	15	30	2
3	40	8255	Finish milling	41.200	40.800	09-Apr-21	D 622	41.038	0.038	S	15	30	2
4	40	8255	Finish milling	41.200	40.800	19-Apr-21	D 1419	41.019	0.019	S	17	30	2
5	40	8255	Finish milling	41.200	40.800	19-Apr-21	D 1419	40.986	-0.014	S	17	30	2
6	40	8255	Finish milling	41.200	40.800	19-Apr-21	D 1419	41.002	0.002	S	17	30	2
7	40	8255	Finish milling	41.200	40.800	26-Apr-21	D 2484	41.022	0.022	S	18	30	2
8	40	8255	Finish milling	41.200	40.800	26-Apr-21	D 2484	41.006	0.006	S	18	30	2
9	40	8255	Finish milling	41.200	40.800	26-Apr-21	D 2484	41.026	0.026	S	18	30	2
10	40	8255	Finish milling	41.200	40.800	03-May-21	D 3299	41.067	0.067	S	19	30	2
11	40	8255	Finish milling	41.200	40.800	03-May-21	D 3299	41.026	0.026	S	19	30	2
12	40	8255	Finish milling	41.200	40.800	03-May-21	D 3299	41.073	0.073	S	19	30	2
13	40	8255	Finish milling	41.200	40.800	09-Apr-21	D 622	41.025	0.025	S	15	30	2
14	40	8255	Finish milling	41.200	40.800	09-Apr-21	D 622	41.010	0.010	S	15	30	2
15	40	8255	Finish milling	41.200	40.800	09-Apr-21	D 622	41.038	0.038	S	15	30	2
16	40	8255	Finish milling	41.200	40.800	19-Apr-21	D 1419	41.019	0.019	S	17	30	2
17	40	8255	Finish milling	41.200	40.800	19-Apr-21	D 1419	40.986	-0.014	S	17	30	2
18	40	8255	Finish milling	41.200	40.800	19-Apr-21	D 1419	41.002	0.002	S	17	30	2
19	40	8255	Finish milling	41.200	40.800	26-Apr-21	D 2484	41.022	0.022	S	18	30	2
20	40	8255	Finish milling	41.200	40.800	26-Apr-21	D 2484	41.006	0.006	S	18	30	2
21	40	8255	Finish milling	41.200	40.800	26-Apr-21	D 2484	41.026	0.026	S	18	30	2
22	40	8255	Finish milling	41.200	40.800	03-May-21	D 3299	41.067	0.067	S	19	30	2
23	40	8255	Finish milling	41.200	40.800	03-May-21	D 3299	41.026	0.026	S	19	30	2
24	40	8255	Finish milling	41.200	40.800	03-May-21	D 3299	41.073	0.073	S	19	30	2
25	40	8255	Finish milling	41.200	40.800	09-Apr-21	D 622	41.025	0.025	S	15	30	2
26	40	8255	Finish milling	41.200	40.800	09-Apr-21	D 622	41.010	0.010	S	15	30	2
27	40	8255	Finish milling	41.200	40.800	09-Apr-21	D 622	41.038	0.038	S	15	30	2
28	40	8255	Finish milling	41.200	40.800	19-Apr-21	D 1419	41.019	0.019	S	17	30	2
29	40	8255	Finish milling	41.200	40.800	19-Apr-21	D 1419	40.986	-0.014	S	17	30	2
30	40	8255	Finish milling	41.200	40.800	19-Apr-21	D 1419	41.002	0.002	S	17	30	2
31	40	8255	Finish milling	41.200	40.800	26-Apr-21	D 2484	41.022	0.022	S	18	30	2
32	40	8255	Finish milling	41.200	40.800	26-Apr-21	D 2484	41.006	0.006	S	18	30	2
33	40	8255	Finish milling	41.200	40.800	26-Apr-21	D 2484	41.026	0.026	S	18	30	2
34	40	8255	Finish milling	41.200	40.800	03-May-21	D 3299	41.067	0.067	S	19	30	2
35	40	8255	Finish milling	41.200	40.800	03-May-21	D 3299	41.026	0.026	S	19	30	2

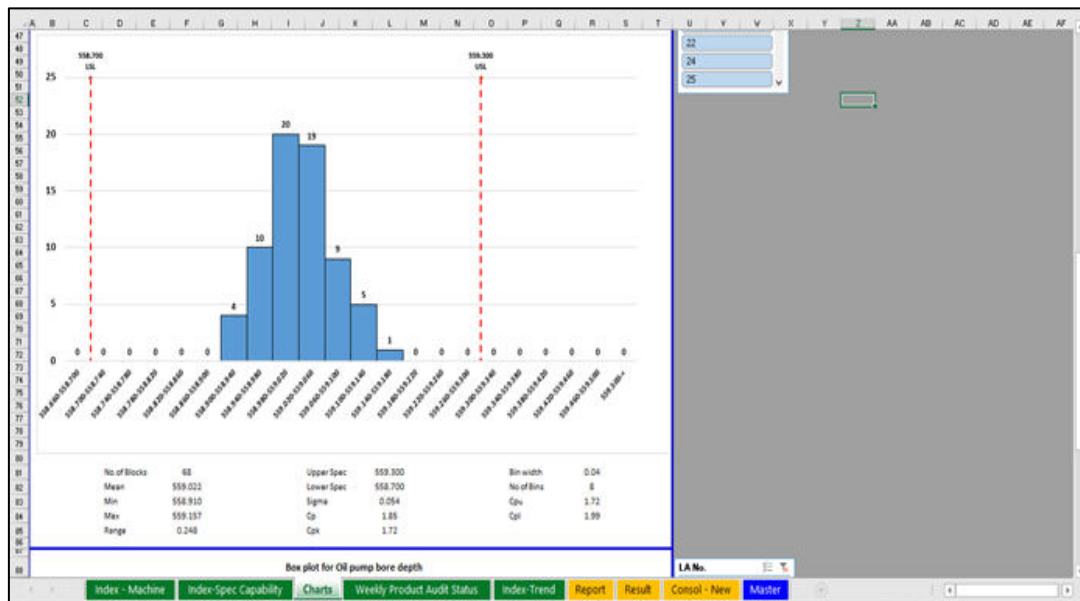
(c)

Line 2 - 3CMM Consol Report for LA No : 8255 - PCN Drilling PCN mtg hole									
LA No : 8255				From : #####					
Opn No : 340				To : #####					
Desc : PCN spot face & Drill PCN mtg hole				No. of Characteristics : 12					
No. of Reports available : 3									
No. of Reports OK : 2									
No. of Characteristic									
Type of Characteristics	No. of Charac.	Status for Spec.		Status for Process Capability					Remarks
		Within Spec	Out of spec	<1	1 to 1.33	1.33 to 1.67	1.67 to 2	>=2	
CTQ	0	0	0	0	0	0	0	0	
Non CTQ	12	6	6	12	0	0	0	0	
No. of Characteristic									
Type of Characteristics	% of Charac.	Status for Spec.		Status for Process Capability					Remarks
		Within Spec	Out of spec	<1	1 to 1.33	1.33 to 1.67	1.67 to 2	>=2	
CTQ	0.0%	0.0%	0.0%	0%	0.0%	0.0%	0.0%	0.0%	
Non CTQ	100.0%	50.0%	50.0%	100%	0.0%	0.0%	0.0%	0.0%	

(d)



(e)



(f)

IV. CONCLUSION

By implementing Statistical Process Control, it has been observed that, Machines that provide data digitally that are more accurate for statistical process control, which is ideal for a statistical process control system. Control Charts are useful for monitoring production process and can be shown digitally by a well-designed system.

Data is better for monitoring and visualisation through applications because all data and visualisation is easily accessible. System customization and any additions to statistical process control are easy since system may be reprogrammed to include new functionalities without requiring extensive use and analysis training. It helps in finding the data variance at any point of production across an entire year and helps in improving the overall production, cost & reduces the time in auditing.

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