"Optimization Of Critical To Quality Parameters Of Vertical Spindle Surface Grinder.

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Abstract -
In order to produce any product with desired quality by machining, proper selection of process parameters is essential. Process capability is to be assessed by using statically process control techniques like control_charts, it reduces the variability in delivery times, completion times control chart in is an important tool for robust design, which offers a simple and systematic approach to optimize a design for performance, quality and cost. The control chart, quality control encompasses all stages of product /process development. However, the key element for achieving high quality at low cost is Design of Experiments (DOE). Quality achieved by means of process optimization is found by many manufacturers to be cost effective in gaining and maintaining a competitive position in the world market. This paper describes use and steps of Statistical process control, Taguchi design of experiments to find a specific range and surface grinding parameters like cutting speed, feed rate and depth of cut to optimize the critical to quality parameter values of response variables like surface finish, parallelism (flatness) in surface grinding of spacer tube of FG 260 gray cast iron Material.

Keywords: Optimization, critical to quality parameter statically process control, speed, feed, depth of cut, flatness, roughness. Design of experiments, Taguchi method, Grinding.

Introduction

Process Currently in Trufit Precision, Karad, Dist.-Satara is a small scale industry which is doing surface grinding machining operation of 600 spacer tube casting components per day for Tata motors. Grinding process is carried on vertical spindle surface grinder having the grinding capacity (250*500mm). During the surface grinding machining the important input parameters are feed, speed, and depth of cut, properties of work piece material such as hardness which affects on the output parameters of surface grinding machine such as majorly work piece flatness of spacer tube and increase in cycle time of production, increase the cost of production. So this type of variation due to men, material and machine, so there is need to study the process and for consistent performance of grinding machine need to identify the factors which contribute to variability and to investigate the effect of variations in various parameters on work piece flatness of spacer tube and cycle time of production of spacer tube in grinding. Surface grinding machine cannot gives the require process capability and it is important parameters for total production process improvement so there is need to study the statically process control and to implement. Spacer tube having tube hardness: 180- BHN is used between hub inner and outer bearings in automobile at Tata motors. Alloying elements affects the mechanical properties of base metal so study of material plays an important role in dissertation work. Composition of work piece of spacer tube [FG:260] cast iron is as given below .

This will be done by collecting data finding causes of problems understanding and managing variability in a process. Samples at various parameters within the process and variations in the process that may affect the quality of the end product or service can be detected and corrected. This will reduce waste as well as unnecessary man and machine time and early detection and prevention of problems.

Statistical process control provides a theory and methodology for improvement also it helps to identify where improvement is needed and control the process and improve the process by reducing the chance causes of variations. so there is need of Statically process control to identify exactly when and where ,how and why the process changed and develop the procedure to eliminate the causes of variation

Statistical process control is a methodology for monitoring a process to identify special causes of variation and need to take corrective action. SPC relies on control charts. Statistical process control is a collection of tools that when used together can result in process stability and variance reduction.

Statistical Process control is the application of statistical methodology in quality control. Hence SPC includes all those operational techniques in quality control which are concerned with sampling and with evaluating samples in order to take adequate decisions on material, products, manufacturing processes, organization etc and are able to satisfy customers' needs. Hence the objective of SPC is basically an economic one.

1.1 SURFACE GRINDING:

Grinding is a form of machining, a material removal process, which is used to create rotational parts by cutting away unwanted material as shown in Figure The grinding process requires a grinding machine or surface grinder, work piece, fixture, and grinder. The work piece is a piece of pre-shaped material that is secured to the fixture, which itself is attached to the grinding machine, and allowed to rotate at high speeds. It can be defined as the machining of an external surface with the work piece is rotatingwith a grinder and with the grinding feeding parallel to the axis of the work piece and at a distance that will remove the outer surface of the work.

2. Design and Specification of component SPACER TUBE and machine

A) Material Properties

Material Properties of SPACER TUBE are as follows:

Material: Structural Steel FG 260.

Sr. No.	Composition	Percentage
1	Carbon	3.1- 3.2
2	Si	1.6-2.1
3	Mn	0.6- 0.8
4	P	Max-.15
	Cr	0.2

Fig : 1 Spacer tube

Sr. No.	Machine	Vertical spindle surface grinder
1	Grinding capacity	225*500 mm
2	Working Surface of Table	225*500 mm
3	Max. Table Travel	250*500 mm
4	Magnate chuck suitable	150 *200 mm
5	Max. Distance Center of Spindle to table	340 mm
6	Vertical Down Feed on Hand Wheel	0.01 mm
7	Micro feed (Elevation)	0.02 mm /1 div.
8	Wheel speed	2800 RPM
9	Wheel dimension	126*50*31.
10	Wheel spindle motor	3 h.p.

3. RESULTS AND DISCUSSION

A correct approach to dealing with several factors is to conduct a statistically designed experiment such as a factorial experiment. In such experimental strategy, factors are varied together instead o f one at a time. Such experimental designs based on statistical approach enable the researcher to investigate the individual effects of each factor (or the main effects) and to determine whether the factors interact. To assess the effect of input parameters on output response variables, large numbers of experimental runs are required and therefore, is a time consuming task. Various control charts in statically process control and design-of-experiment methods are widely used to overcome this problem.

a. A simple, efficient and systematic method to optimize product/process to improve the performance or reduce the cost.

b. Help arrive at the best parameters for the optimal conditions with the least number of analytical investigations.

c. It is a scientifically disciplined mechanism for evaluating and implementing improvements in products, processes, materials, equipments and facilities.

Most of the researchers have reported improvement in surface roughness with an increase in cutting speed.

Involved following steps [9].

a. Definition of the problem

b. Selection of response variables

c. Selection of control parameters and their levels

e. Identification of control factor interactions

f. Conducting the (experimental procedure and set-ups)

h. Analysis of the data and prediction of optimum level

a. Definition of the problem

A brief statement of the problem under investigation is “Optimization of critically to quality parameters of vertical spindle surface grinder” grinding gray cast iron”

c. Selection of response variables

In any process, the response variables need to be chosen so that they provide useful information about the performance of the process under study. Table 4.1 show various parameters used while designing the experiments. By considering all parameters given below and by taking literature review as technical base MRR, Surface finish (Ra) and tool wear are chosen as response variables.

d. Selection of control parameters and their levels:

The process parameters affecting the characteristics of turned parts are: cutting tool parameters tool geometry and tool material; work piece related parameters- metallographic, hardness, etc.; cutting parameters- cutting speed, feed, depth of cut, dry cutting and wet cutting.

Selection of cutting speed:

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Available literature on machining indicates that the influence of cutting speed on cutting forces and surface roughness changes with the cutting speed. Similarly, the effect of cutting speed on surface roughness has not been clearly understood so far. Most of the researchers have reported improvement in surface roughness with an increase in cutting speed. Also researchers, who have studied tool wear pattern, suggest to take increasing level of cutting speed which allows better understanding of wear patterns. Machine constraint is another reason for selection of cutting speed.

Selection of feed:

It is known from the fundamentals of metal cutting that feed rate influences the chip cross-sectional area and hence the machining forces. It influences pitch of the machined surface profile and hence the machined surface roughness too [10]. An increase in feed rate increases the amount of cracks, pits on the machined surfaces due to reinforcement pull-out and fracture, which then deteriorates the surface quality/integrity and introduces higher thermal stresses on the machined surfaces. Also, effect of change in tool geometry in conjunction with feed rate on the surface quality/integrity is not adequately clear too.

Selection of depth of cut:

It is known that depth of cut influences the chip load by change in chip cross-sectional area and hence the cutting forces, which in turn could influence the stability of the machining process and machined surface characteristics. The surface roughness deteriorates with an increase in depth of cut, which is attributed to the formation of unstable BUE at lower feed and higher depth of cut. However, most of the investigations have reported that surface roughness has little and/or no dependence on depth of cut. Further, it is envisaged that a change in depth of cut may vary the rate of plastic deformation. This in turn influences the mechanical and thermal stresses and changes the residual stresses on the machined surfaces. Considering the literature review and the available machine settings following process parameters were selected for the present work:

a. Cutting speed

b. Feed

d. Depth of cut

The ranges of the selected process parameters were ascertained by conducting some preliminary experiments using one variable at a time approach. The selected parameters were kept fixed during the entire experimentation.

Sn.	Speed rpm	Feed mm	Doc mm	Flatness (parallelism) in microns	Surface roughness inmicrons.
1	2600	0.01	0.02	0.022	0.5170
2	2600	0.01	0.03	0.022	0.7200
3	2600	0.01	0.04	0.017	0.8120
4	2600	0.02	0.02	0.023	0.6620
5	2600	0.02	0.03	0.021	0.7950
6	2600	0.02	0.04	0.016	0.8610
7	2600	0.03	0.02	0.022	0.6900
8	2600	0.03	0.03	0.021	0.8140
9	2600	0.03	0.04	0.017	0.8700
10	2800	0.01	0.02	0.023	0.5900
11	2800	0.01	0.03	0.021	0.7800
12	2800	0.01	0.04	0.017	0.8420
13	2800	0.02	0.02	0.022	0.7450
14	2800	0.02	0.03	0.020	0.8010
15	2800	0.02	0.04	0.018	0.8580
16	2800	0.02	0.02	0.021	0.7510
17	2800	0.03	0.03	0.019	0.8480
18	2800	0.03	0.04	0.017	0.9130
19	3000	0.03	0.02	0.022	0.6810
20	3000	0.01	0.03	0.021	0.7910
21	3000	0.01	0.04	0.017	0.8510
22	3000	0.01	0.02	0.023	0.7300
23	3000	0.02	0.03	0.021	0.8160
24	3000	0.02	0.04	0.016	0.9020
25	3000	0.03	0.02	0.022	0.7565
26	3000	0.03	0.03	0.019	0.8670
27	3000	0.03	0.04	0.016	1.0360

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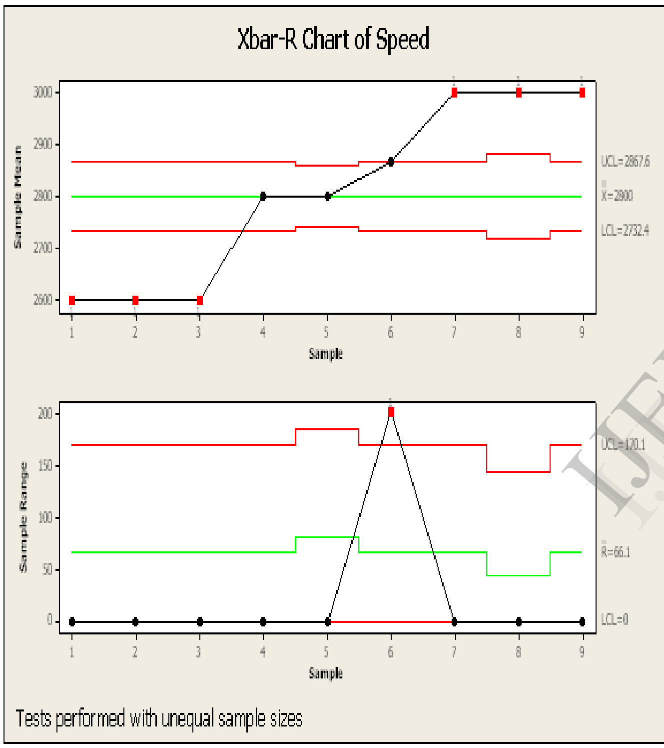
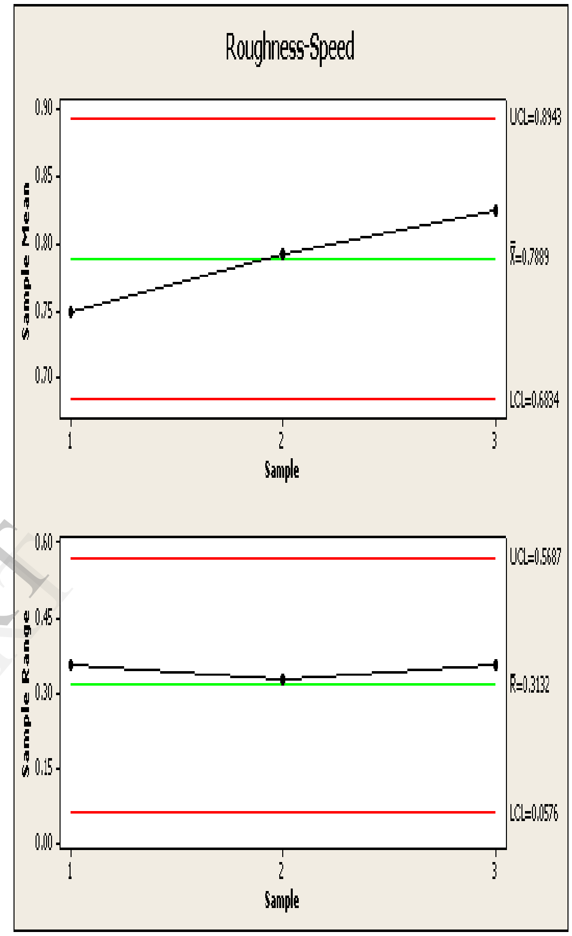
By using statically process control we are calculated the X bar- R chart for critical to quality parameters such as speed, feed and depth of cut as shown below

Graph no. 1 : shows speed for surface grinding machine is 2800 rpm Upper control limit is 2957.6 rpm and lower control limit is 2732.4 rpm so by using control chart method in SPC shows speed is 2800 rpm which is selected for output parameters that is flatness and roughness for given surface grinder



Graph no. 1



Graph no. 2

Graph no. 2 : shows Roughness for surface grinding machine is 0.7889 mm (measured in microns) Upper control limit is 0.8943 mm and lower control limit is 0.6834 mm so by using control chart method in SPC shows roughness is 0.7889 mm (measured in microns) which is selected for output parameters that is roughness for given surface grinder

Fig 2 shows Mitutoyo surface meter for measurement of surface roughness in microns is used for experiment work.

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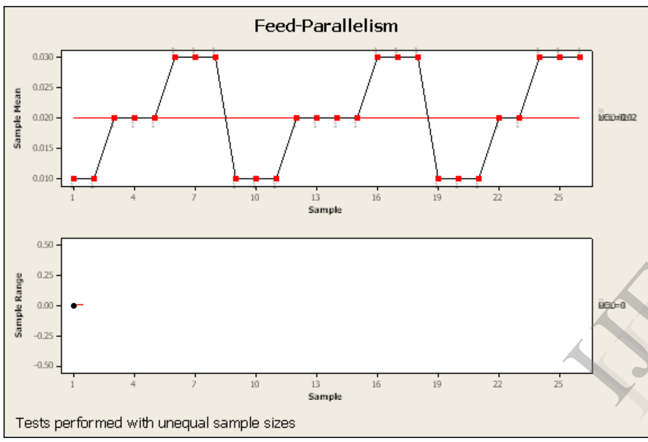
Figure 2: Mitutoyo Surface meter

Graph no. 3: shows feed –parallelism graph of given sample i.e. spacer tube for surface grinding machine. Feed is 0.02 mm Upper control limit is 0.025 mm and lower control limit is 0.010 mm so by using control chart method in SPC shows feed is 0.02 mm and parallelsim (flatness) is 0. 02 microns (.02 is given tolerance measured in microns) which is selected for output parameters that is roughness for given surface grinder



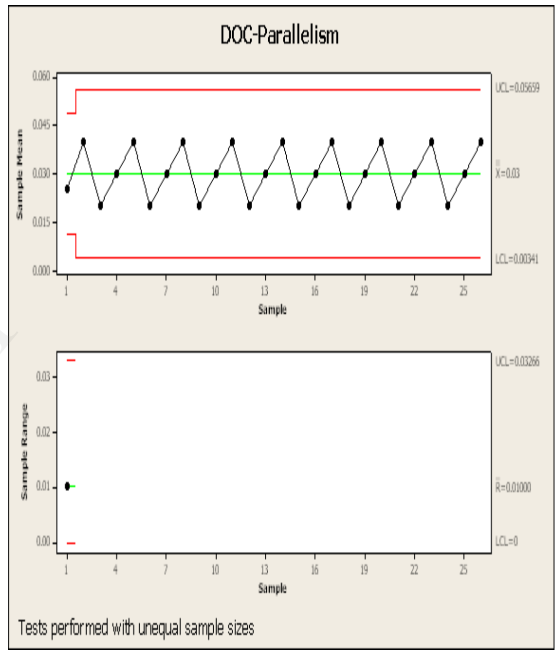
Graph no. 3

Graph no. 4 : shows Depth of cut and parallelism for surface grinding machine is 0.03mm mm Upper control limit is 0.05659 mm and lower control limit is 0.03341 mm so by using control chart method in SPC shows depth of cut is 0.03 mm of given sample i.e spacer tube for surface grinding machine.

Graph no.5 : shows Roughness for surface grinding machine is 0.7889 mm (measured in microns) Upper control limit is 0.8943 mm and lower control limit is 0.6834 mm so by using control chart method in SPC shows roughness is 0.7889 mm (measured in microns) which is selected for output parameters that is roughness for given surface grinder

Graph no. 6 shows main effect plot for Roughness for surface grinding machine so by using control chart method in SPC for roughness speed is s selected for output parameters roughness is 0.7889 microns i.e. is equal to 0.8 microns for given surface grinder.

For this output parameters
Speed: 2800 rpm
Feed: 0.02 mm
Depth of cut: 0.03 mm



Graph no. 4

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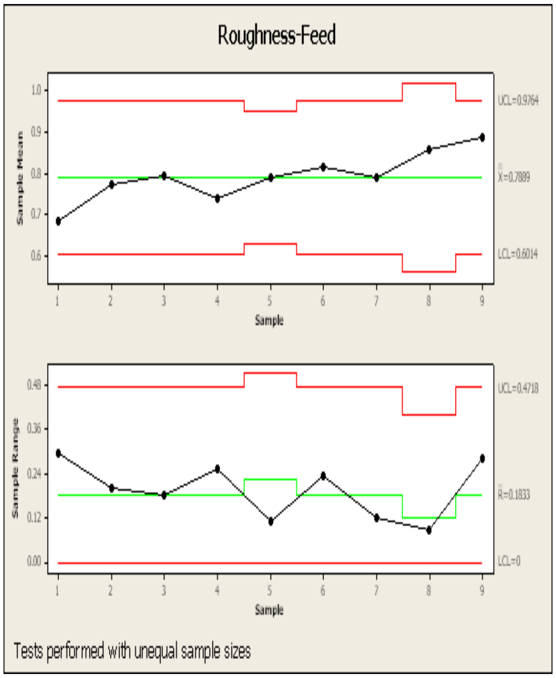
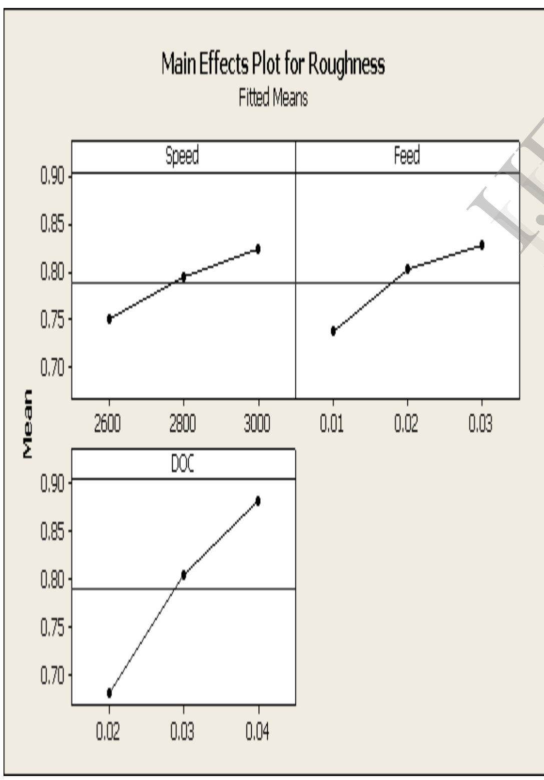


Graph no. 5



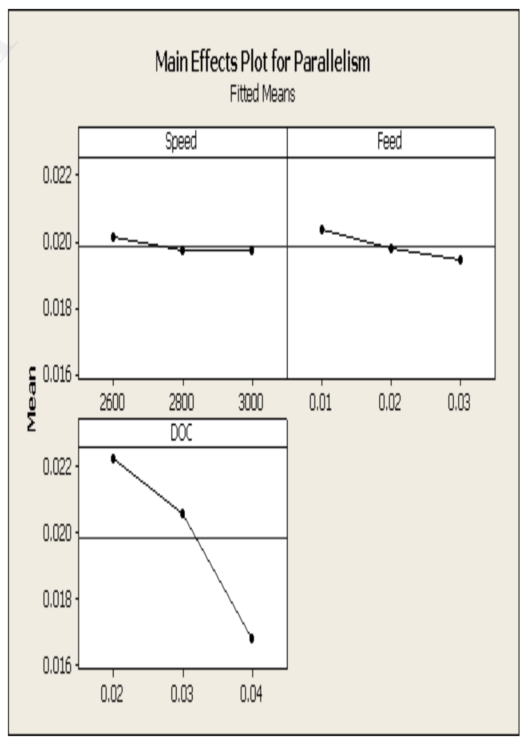
Graph no. 6

Graph no. 7 shows main effect plot for parallelism for surface grinding machine so by using control chart method in SPC for parallelism speed is s selected for output parameters parallelism is 0.02 microns for given surface grinder.

For this output parameters
Speed: 2800 rpm
Feed: 0.02 mm
Depth of cut: 0.03 mm

Graph no. 8 shows histogram of roughness
Mean frequency: 0.7889
No of spacer tube is 27 graph shows between 0.7 and 0.9 roughness is accepected.

Graph no. 9 shows time series plot for speed, feed and depth of cut, roughness, parallelism
For this output parameters
Speed: 2800 rpm
Feed: 0.02 mm
Depth of cut: 0.03 mm



Graph no. 7

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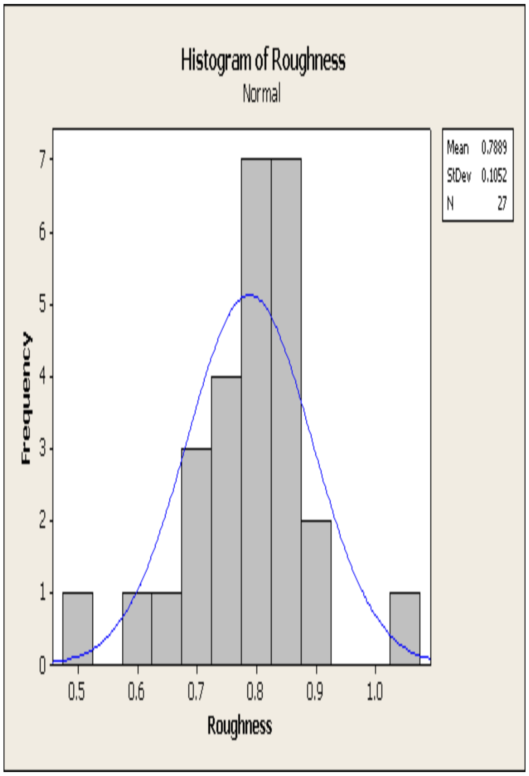
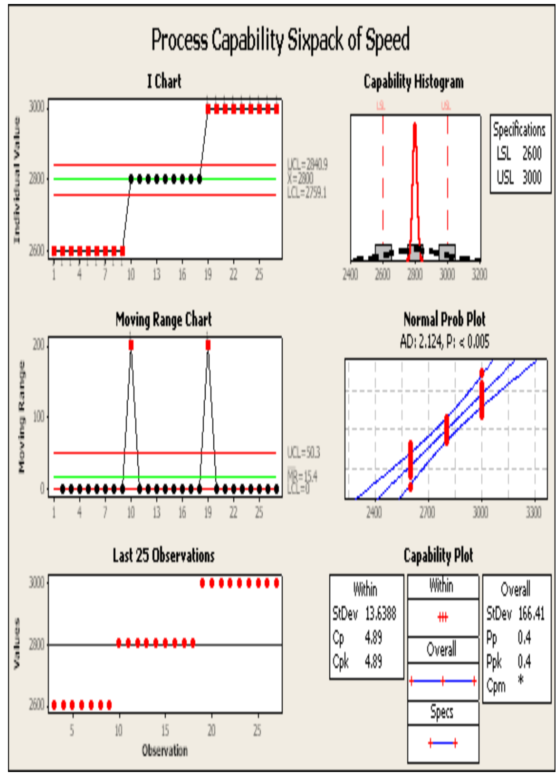


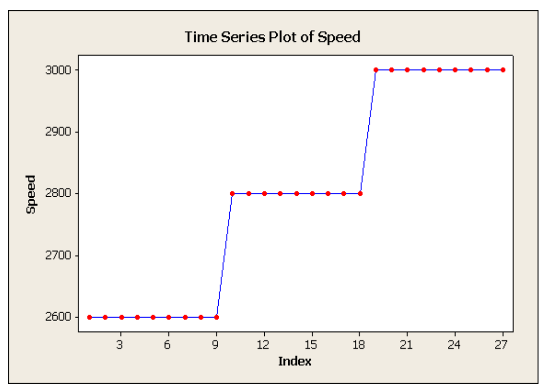
Graph no. 8



Graph no. 10

Graph no. 10 shows process capability six-pack of speed capability of histogram and I- chart, moving range chart capability plot
Cp: 4.89 Cpk: 4.89 Pp; 0.4, Ppk : 0.4

Graph no. 12 shows main effect plot for SN ratio Shows most critical to quality parameters is depth of cut. For output parameters roughness, parallelism
For this output parameters
Speed: 2800 rpm
Feed: 0.02 mm
Depth of cut: 0.03 mm



Graph no. 10
Graph no. 11 Run chart for speed

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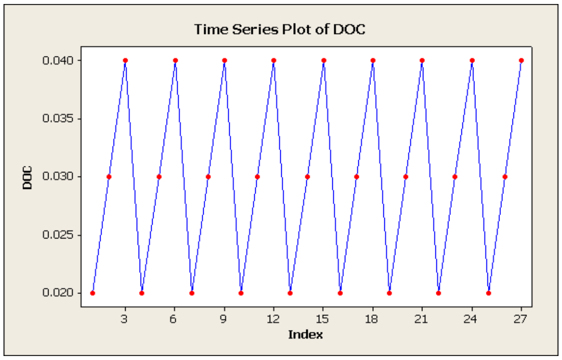
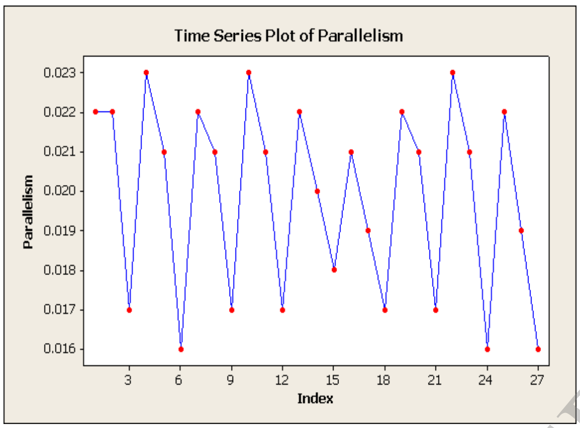
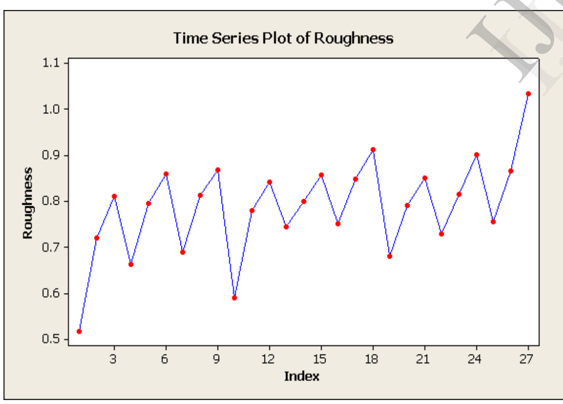
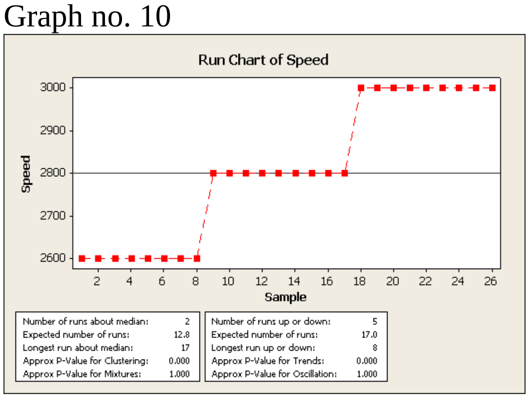
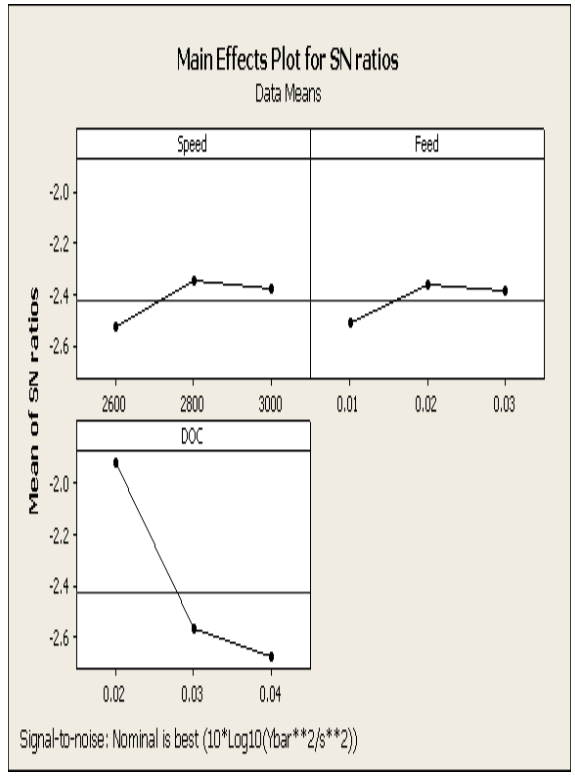






Graph no. 10





Graph no.10 Main effect plot for SN ratio

Overall discussion;

This paper has discussed the optimization of critical to quality parameters of vertical spindle surface grinder by the application of statically process control method such as control chart, quality control to find and optimize most critical parameters for specific range and combinations of grinding parameters like cutting speed , feed rate and depth of cut to achieve optimal values of response variables like surface roughness, parallelism (flatness) in surface grinding of spacer tube of FG 260 gray cast iron Material. It is effective methodology to find out the effective performance and machining conditions. Control chart design offers a simple, systematic approach and can reduce number of experiment to optimize critical to quality parameters design for performance, quality and manufacturing cost. It is a scientifically disciplined mechanism for evaluating and implementing improvements in products, processes, materials, equipments and facilities

CONCLUSION

From the results obtained it is concluded that as the by using control chart method and other methods we conclude that depth of cut is most critical to quality parameters hence Optimization of surface grinding parameters such as speed, feed and depth of cut is required to provide required output .

FUTURE SCOPE

Present dissertation work covers the optimization, of critical to quality parameters but still it has a scope for control the quality and material optimization determine whether the process is "in statistical control or not and to increase the customer demand.

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