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SPC Study of the Key Process of Varieties and Small Batch Production Line

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Abstract

According to the characteristics of variety and small batch production line and the existing problems, puts forward three layers of technology implementation framework workshop key procedure of dynamic SPC; And the use of combined with Hugh Hart control charts and cumulative sum control chart of statistical process control, to solve the Hugh Hart control chart on abnormal reaction of small offset insensitive question.

Keywords*: variety and small batch; Production line； The key process； SPC*

1. Introduction

In recent years, many scholars in quality control for variety and small batch production mode has been a lot of research, and achieved a very fruitful research results. The literature [1] presents a similar element procedure based on similarity analysis method of SPC, the quality control of variety and small batch production process; Literature [2] put forward the concept of virtual process, through the establishment of procedure quality feature coding system, using similar procedures coding process division will be the same as a virtual procedure-manufacturing theory, the composition of virtual mass, in order to solve the problem of variety and small batch-processing of small amount of sample data; document [3].would be similar to different process quality characteristics-process values were standardized data transform, then sample points will be drawn in the same control diagram, determine the procedure quality control documents [4] the probability integral transform, will be subject to sample quality characteristic data of normal distribution into obeys normal distribution data, using the transformed data to establish a standard control chart, avoids the small sample-environment for the mean and standard deviation of estimation problems are not allowed. Existing research mainly adopts the theory of similarity process, quality characteristics data has occurred to make standard-conversion to achieve specific products from quality control to quality state of the conversion process control, solves the problem of insufficient quality of sample data.

Rapid renewal of products of the trend has now spread to all industries, enterprises are faced with the economic-pressure to reduce the inventory, also makes them-naturally selected variety, small batch production mode. Especially semi-finished products processing-industry, we must realize the smaller batches, or even "timely processing" of the supply mode, at the same time, in the face of increasingly fierce price competition. The flexible-processing requirements relate to each to obtain the value of the processing steps, but mostly in the blanking process of [5]. Firstly, according to the variety and small batch workshop production line balance and improvement of analysis, on the basis of this, put forward a kind of key process of SPC three layer technology implementation framework, this framework to solve the dynamic problem of the quality control of Multiple functional information interaction

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terminal based on real-time acquisition of locale quality data, using a combination of Hugh Hart control charts and cumulative sum control chart statistical process control, control chart to solve Hugh Hart abnormal reaction of small offset insensitive problems, finally, the bad phenomenon of key process has been put forward after analysis of experimental design to determine the best factors combination process.

2. Implementation Framework of Variety and Small Batch of Key Process of SPC Technology

The implementation framework includes acquisition layer, control layer and the improvement of level 3 levels of variety and small batch key procedure of dynamic SPC technology :

Acquisition layer is a set of networked manufacturing in one multiple functional interactive information terminal, can be dynamic acquisition of locale quality data.

The control layer includes the quality of sample data standardization transformation, Hugh Hart control combined with map and CUSUM control chart method, provide technical support for dynamic quality statistical process control;

The main function of modified layer is the design and arrangement of the experimental design method based on the experimental determination of related parameters, the optimum combination of factors in the process of.

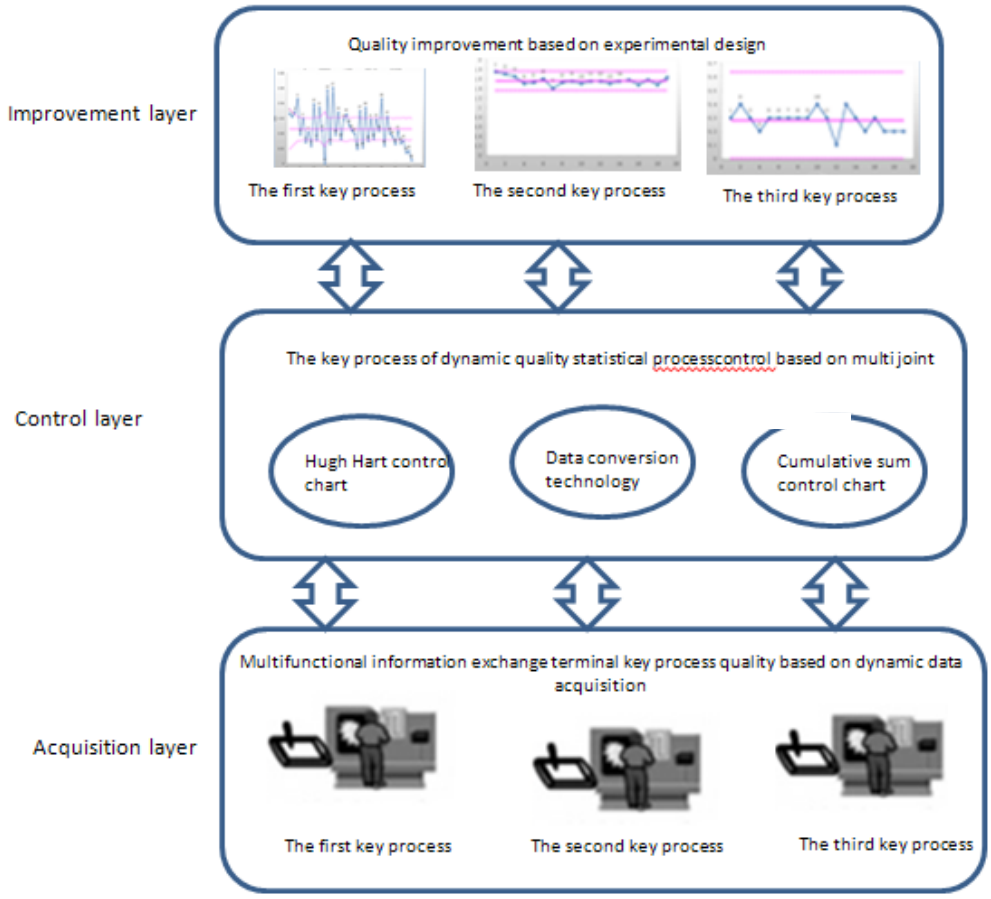


Figure 1. Many Varieties of Small Batch Key Procedure of the Three Layers of the SPC Technology Realization Frame Chart

3. SPC Study on the Varieties and Small Batch of Key Process based on the Joint

The key process in the production of manufacturing workshop production personnel, processing equipment, measuring tools, production environment and so on have tended to be stable, satisfy the similarity process requirements. Therefore, using the theory of similarity process, standardization of data conversion, to solve the problem of insufficient quality of sample data. Hugh Hart control chart on the quality state of significant migration is more sensitive, for small offset (generally refers to offset less than 1.5) is not sensitive, and CUSUM control chart on the quality state of small offset detection ability, good therefore, using a combination of CUSUM control chart and Hugh Hart control chart in SPC key process quality control Hugh Hart, solve the graph of small offset insensitive control problems, so as to achieve the effective control of [6] on the quality of the abnormal state of the.

3.1 Standardization of Data Conversion

The objectives of the workshop processing generally give each working procedure value and tolerance zone, so the use of relative tolerance to multiple product quality sample data standardization transformation, and then the sample data after conversion of drawing in a quality control chart.The key process of workshop equipment is more processing capacity of machining center can be strong,automatic tool change continuously processing a plurality of step, after the completion of each parts process will produce multiple quality characteristics data, based on the method of relative tolerance, transformation process quality characteristics data standardization, the formula for calculating the:

$$Z_{ijk} = \frac{X_{ijk} - O_{ijk}}{T_{ijk}} \quad (1)$$

In the formula, Z_{ijk} is the fourth part first part in the first step the quality characteristic value, X_{ijk} is the first component parts in the first step the quality characteristics of the actual measured value, O_{ijk} is the first step the quality of parts in the first part of the target value (tolerance zone center), T_{ijk} is the first step in the quality tolerances of parts in the first part of the belt.

3.2 The Quality of Statistical Process Control Chart to Control

First , based on sample data standardization transformation, Using $\overline{Z} - Rs$ (moving range control chart for monitoring of Hugh Hart, Mean control chart, sample data in standardized transformation after the first article parts in the moving range first step value R_{sijk} and the estimation of population variance σ are[7]:

$$\overline{Z} = \frac{1}{NML}\sum_{i=1}^{N}\sum_{j=1}^{M}\sum_{k=1}^{L} Z_{ijk} \quad (2)$$

$$R_{ijk} = \left| Z_{ijk} - z_{ij(k-1)} \right| \quad (3)$$

$$\overline{R_{ijk}} = \frac{1}{NM(L-1)}\sum_{i=1}^{N}\sum_{j=1}^{M}\sum_{k=2}^{L} R_{ijk}$$

$$\hat{\sigma} = \frac{\overline{\mathrm{R}}}{\mathrm{d}_2} \quad (4)$$

In the formula, N is the total number of batches of machined parts, M is the total number of each batch of parts processing, L is the total number of processes each

batch processing parts experience. Among them, The sample size of R_S is 2, Look-up table to know when N=2, $d_2 = 1.128$, $D_3 = 0$, $D_4 = 3.267$, the mean and moving range control chart in the formula are [8]:

$\overline{X}$ Control

$$CL = \bar{\bar{x}}$$
$$UCL = \bar{\bar{x}} + A_2 \overline{R}$$
$$LCL = \bar{\bar{x}} - A_2 \overline{R} \quad (5)$$

R Control

$$CL = \overline{R}$$
$$UCL = D_4 \overline{R}$$
$$LCL = D_3 \overline{R} \quad (6)$$

4. The Example Analysis

Now to the quality of the machining process of circular saw blade control of A company as an example, the dynamic SPC control and improved quality verification of variety and small batch machining workshop of the key process. For this procedure of packing plastic box to detect the packaging process is in a stable condition, has carried on the statistics on the production defect rate in March, as shown in Table 1.1. Each work piece tolerances require is part of sampling inspection of multiple functional information interaction terminal real time data acquisition based on.

Table 1. Quality Characteristic Data Table Circular Saw Blade Machining Process

Sample	Tolerances (10-2m)				sum	$\overline{X}$	R(10-2m)
1	1.4	1.7	1.6	1.8	6.5	1.625	0.175
2	1.6	1.8	1.7	1.9	7	1.75	0.15
3	1.5	1.7	1.9	1.7	6.8	1.7	0.2
4	1.5	1.8	1.6	1.7	6.6	1.65	0.15
5	1.4	1.4	1.6	1.6	6	1.5	0.1
6	1.5	1.7	1.5	1.4	6.1	1.525	0.175
7	1.7	1.4	1.6	1.7	6.4	1.6	0.1
8	1.6	1.4	1.3	1.3	5.6	1.4	0.2
9	1.7	1.4	1.5	1.5	6.1	1.525	0.175
10	1.6	1.4	1.5	1.7	6.2	1.55	0.15
11	1.7	1.5	1.3	1.5	6	1.5	0.2
12	1.4	1.5	1.6	1.7	6.2	1.55	0.15
13	1.5	1.6	1.6	1.5	6.2	1.55	0.05
14	1.4	1.3	1.6	1.7	6	1.5	0.2

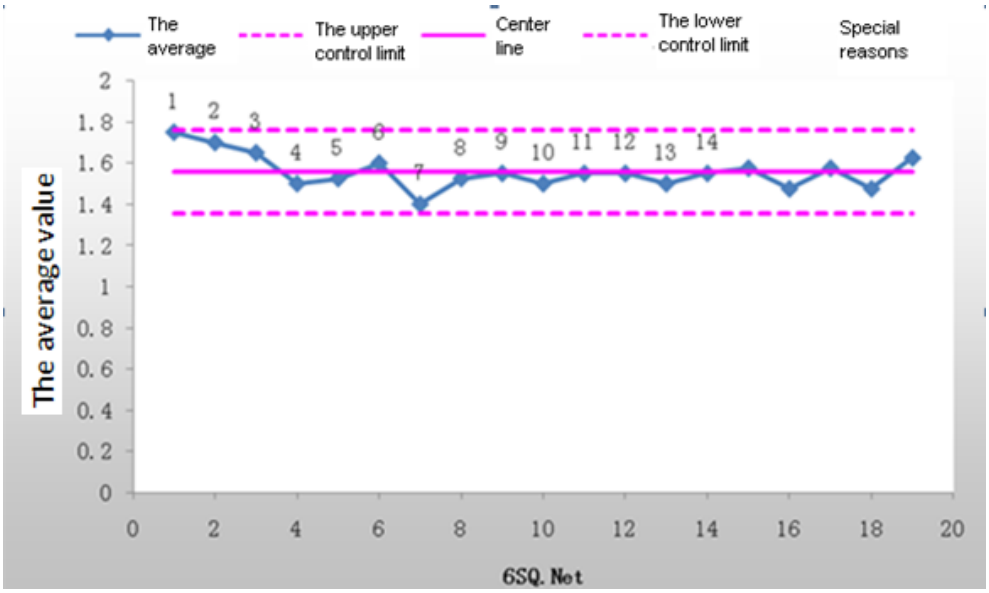
15	1.5	1.6	1.7	1.4	6.2	1.55	0.15
16	1.5	1.6	1.7	1.5	6.3	1.575	0.125
17	1.6	1.5	1.3	1.5	5.9	1.475	0.125
18	1.5	1.6	1.5	1.7	6.3	1.575	0.125
19	1.4	1.4	1.5	1.6	5.9	1.475	0.125
20	1.6	1.5	1.7	1.7	6.5	1.625	0.125
				sum	6.24	1.56	0.1475

4.1 SPC Analysis

Using the X-R diagram, use the formula (1.1-1.5) to calculate the X bar-R limit, type: D4, D3, A2 is a constant, with their sample size is different, when n=5, the tables: A2 =0.729, D4=2.282, D3 =0, =2.059,
After calculation, draw:

$$\begin{cases} CL = 1.56 \\ \begin{cases} UCL = 1.67 \\ LCL = 1.45 \end{cases} \\ \begin{cases} CL_R = 0.15, \\ UCL_R = 0.34, \\ LCL_R \end{cases} \end{cases}$$

The sample size is less than 7, limit control no range. Draw a X bar-R control chart as shown in Figure 2



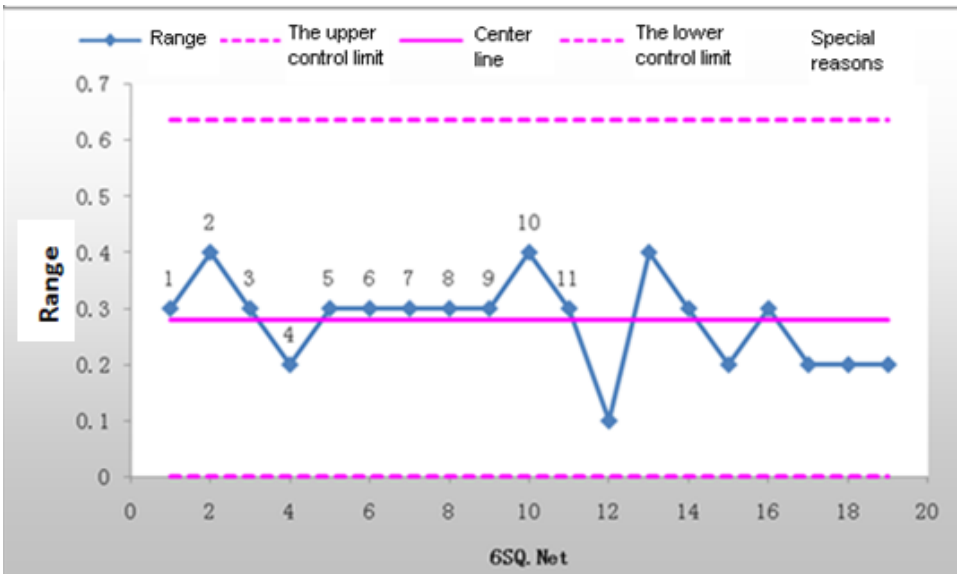


Figure 1.2 X bar-R Control Chart

4.2 Do the Analysis of Process Capability for Further

$$\hat{\sigma} = \frac{\overline{R}}{d_2} \tag{7}$$

=0.15/2.059

= 0.072，

$$Z_{USL} = (USL - \overline{\overline{x}}) / \hat{\sigma}$$

$$= (1.73\text{-}1.56)/0.072 \tag{8}$$

=2.36

$$Z_{LSL} = (\overline{\overline{x}} - LSL) / \hat{\sigma} \tag{9}$$

= (1.56-1.38)/0.072

=2.5

Bilateral specifications:

$$Z=\text{Min}\ (\ Z_{USL}\ ,\ \ Z_{LSL}\ ) =2.36,$$

Check table of normal distribution of [9], P=7.69E-02, so the bilateral 2P=0.1538,

So 15.38% of the unqualified rate.

The following is the use of Min tab software to generate the process capability chart:

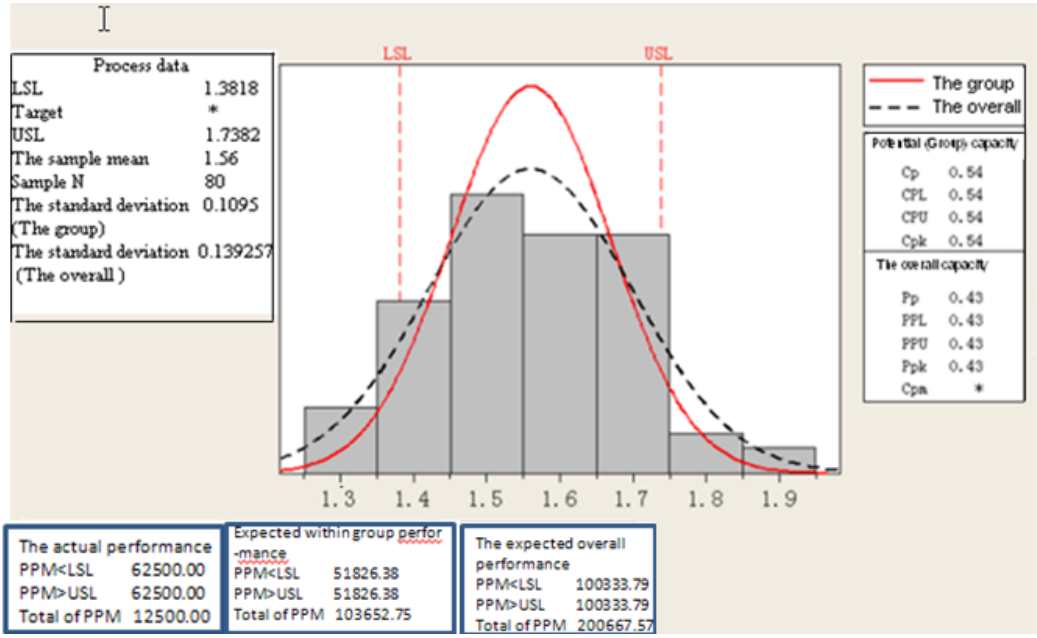


Figure 3. Process Capability Chart

5. Summary

According to the characteristics of the variety and small batch production line and the existing problems, puts forward three layers of technology implementation framework workshop key procedure of dynamic SPC, and using a combination of Hugh Hart control charts and cumulative sum control chart of statistical process control,and finally through the example analysis, verify the accuracy using a combination of Hugh Hart control charts and cumulative sum control chart the study of SPC, so as to solve the problem of Hugh Hart control chart on abnormal reaction of small offset insensitive question.

References

[1] Y Shuping, G Fu, "The foundation of Industrial Engineering[M]",Beijing: Mechanical Industry Press, **(2007)**, pp. 7-215.
[2] W Qiufang, "Production line balancing design model and algorithm [J]", Journal of Wuhan Institute of iron and steel , vol. 3, no. 15, **(1993)**, pp. 86-87.
[3] S Jihong, "Analysis and improvement of SMT in fast changing process[J]", application technology, vol. 10, **(2011)**, pp. 157-159.
[4] H Zhenguo, "Application of [J]. production management", configure management technology in site management, vol. 8, **(2011)**, pp. 41-43.
[5] C Xiaojuan, C Defu, "Application of work study on laptop test efficiency in ascension[J]". Industrial Engineering and management, vol.15, no. 1, **(2010)**, pp. 121-125.
[6] C Jun, Y Chao, L Fei, L Jincai, Y Sheng, "Many varieties of small batch machining workshop key procedure of dynamic SPC research and Application [J]". Chinese mechanical engineering, vol. 22 , no. 23, **(2011),** pp. 2822-2825.
[7] W Junbo, Y Jian, "Application of statistical analysis in quality management[J]". (**2006)** Dec/.
[8] C Xueping, Q Xiwang, "Technology application and several problems that should pay attention to statistical process control[J]", Shanghai, **(2008)** first
[9] T Xuemin, C Yuping, "Status and Prospect of research in statistical process control [J]", in Shandong, **(2008)** Aug.

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