S E L E C T E D E N G I N E E R I N G P R O B L E M S
N U M B E R 6
I N S T I T U T E O F E N G I N E E R I N G P R O C E S S E S A U T O M A T I O N
A N D I N T E G R A T E D M A N U F A C T U R I N G S Y S T E M S

Iwona PAPROCKA*, Angelika DZIĘGIEL
[1]Silesian University of Technology, Institute of Engineering Processes Automation and Integrated Manufacturing Systems, Gliwice
*iwona.paprocka@polsl.pl

THE STATISTICAL CONTROL OF THE MEASURING PROCESS CAPABILITY OF VERTICAL DISPLACEMENT OF THE HEAD RESTRAINT - THE SECOND PART, CASE STUDY

Abstract: In the paper, two techniques of the statistical process control, namely: histogram and process capability are applied to examine whether a process is statistically controllable and to identify disturbances that occur in the process. The objective is to evaluate the capability of the measuring process of vertical displacement of the head restraint. In the measuring process, forces that are used to displace the head restraint up and down are recorded. The analysis consists of checking whether the lifting and lowering forces of the head restraint belong to the required ranges of forces. The processes of displacement of the head restraint up and down are characterised by a high potential, but a poor centering. In order to improve the centering of the process, causes of defects are identified.

1. Introduction

In the paper, two techniques of the statistical process control (SPC), namely: histogram and process capability are applied to examine whether a process is statistically controllable and to identify disturbances that occur in the process. The objective is to evaluate the capability of the measuring process of vertical displacement of the head restraint. Factors that influence over the control process of vertical displacement of the head restraint are identified. In the first paper under the title of: "The statistical control of the measuring process capability of vertical displacement of the head restraint - the first part, theory", various techniques of the SPT were presented namely: histogram, control cards, machine capability and process capability. The SPC allows one to objectively "look at" production, provides the knowledge about the efficiency of the process, as well as any deviations from the norm and modes of their formation [4].

2. Research objective

The research objective is to evaluate the capability of the measuring process of vertical displacement of the head restraint by performing the statistical quality control. In the measuring process, forces that are used to displace the head restraint up and down are recorded. The analysis consists of checking whether the lifting and lowering forces of the head restraint belong to the required ranges of forces.

The controlling machine (Fig. 1) provides the results in N (Newtons). The standards for the head restraint displacement are as follows:

- lifting force equals 55 N. and the tolerance range equals ± 10 N.
- lowering force equals 55 N. and the tolerance range equals ± 10 N.

Fig. 1. Measurement of the friction of the head restraint ejecting.

Defects that may occur during the operation execution are as follows:

- too high frictional force which prevents the movement of the head restraint. The reason for this may be the lack of lubrication of pins, resulting in a high friction.
- clearances in sleeves that cause that the head restraint "pops" from the chair during displacement of the head restraint up. This may be caused by wrong installation or by using too much grease.
- noise due to a small amount of grease.

3. Assembly and the measurement process

A production operator receives a head restraint from the trolley of items. The pins of the head restraint are then placed in the lubricator (Fig. 2) in order to apply the lubricant which reduces friction and enables to displace the head restraint up and down (height adjustment). After the operation execution, the worker takes the head restraint out of the machine, and subsequently mounts it in sleeves of the car seat. A very important point is to check manually that the head restraint is working well. The instruction of installation and measurement of the head restraint in the workstation is presented in Fig. 3.

Assembled seat arrives to the auditing station. Operators of the auditing station, control the occurrence of possible defects. The measurement involves checking the displacement forces of the head restraint of the seat on the production line. In case of exceeding the standards set for the displacement of the head restraint up and down, the worker removes the problem by replacing the defective component or by placing the head restraint in lubricator. It can happen that the operator has missed this operation by the routine of this action.

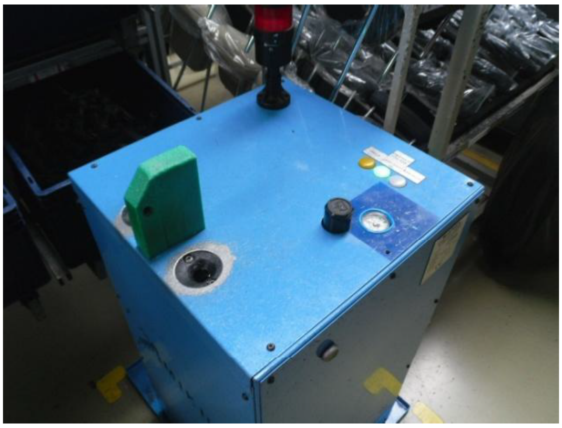

Fig. 2. The lubricator of the head restraint pins

1. Attach the car seat on the assembly stage following the instruction of attaching of the front seat .
2. Perform 5 moves of the head restraint to verify proper operation. Set the head restraint, the position in the axis, the frame according to the fixed code.
3. Fit the tool 31 under the head restraint (Fig.1) and make a move of the server to obtain friction.
4. Adjust the seat position for 3 free meshes to the front when viewed from the bottom and backrest tilt 60 degrees using a spirit level.
5. Measure and store the result in the Control card of the final product.

Fig. 3. The instruction of installation and measurement of the head restraint.

4. The measurement results

Tests were performed for 10 head restraints selected with the given frequency. The values of friction forces obtained during the displacement of the head restraints up and down are presented in the tab. 1. The continuous control takes place using histograms that provides the information about mistakes and about not meeting the standards. Thus, it is possible to react quickly to defects occurrence.

Based on data from Tab. 1 on the head restraint displacement up, a histogram in the program Statistica is build (Fig. 4). The displacement of the head restraint up is correct, since the friction force is located within the standards (between LSL, USL). C_p and C_{pk} indices were calculated. C_p = 3.32 and C_{pk} = 1.58. The difference between the both values of indicators equals almost 1.5, thus the process is characterised by a high potential (C_p), but is poorly centered (a low value of the C_{pk}).

Tab. 1. The measuring report of the head restraint displacement up and down.

The measurement number	The adjustment force of the head restraint up	The adjustment force of the head restraint down
1	61,2	49,8
2	59,1	51,2
3	59,3	50,5
4	54,5	51,1
5	55	53,4
6	58,2	54,1
7	61,1	53,6
8	60,8	52,8
9	58,3	51,7
10	58,5	50,9

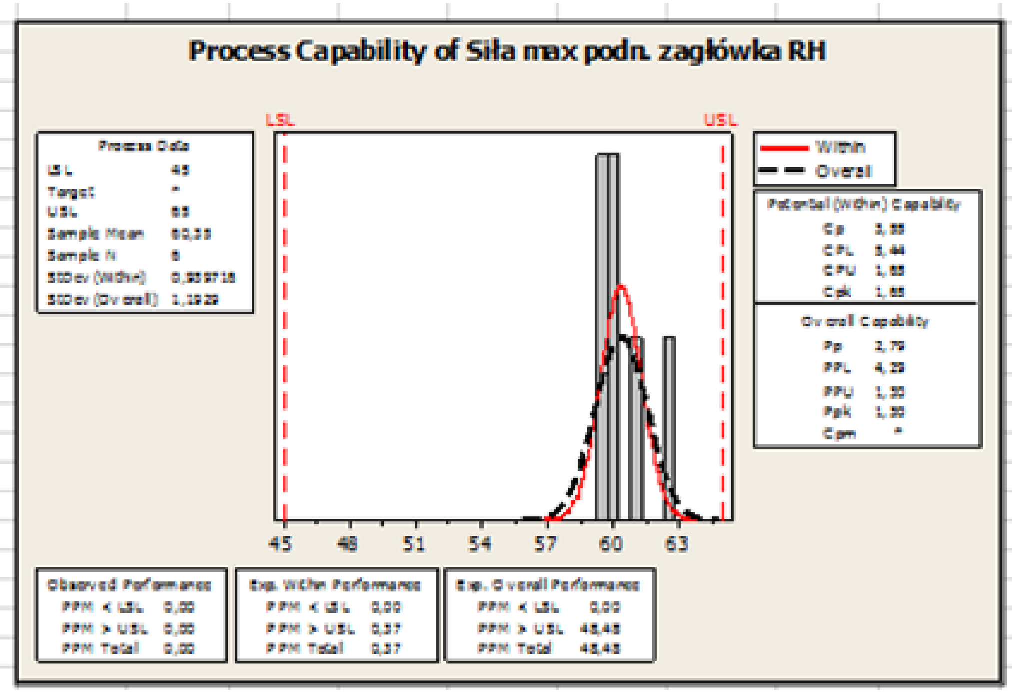

Fig. 4. The maximum friction force achieved during the head restraint displacement up.

Based on data from Tab. 1 on the head restraint displacement down, a histogram in the program Statistica is build (Fig. 5). The displacement of the head restraint down is correct, since the friction force is located within the standards (between LSL, USL). C_p and C_{pk} indices were calculated. C_p = 2.51 and C_{pk} = 1.56. The difference between the both values of indicators equals almost 1, thus the process is characterised by a high potential (C_p), but is poorly centered (a low value of the C_{pk}). In order to improve the centering of the process, causes of defects are necessary to identify.

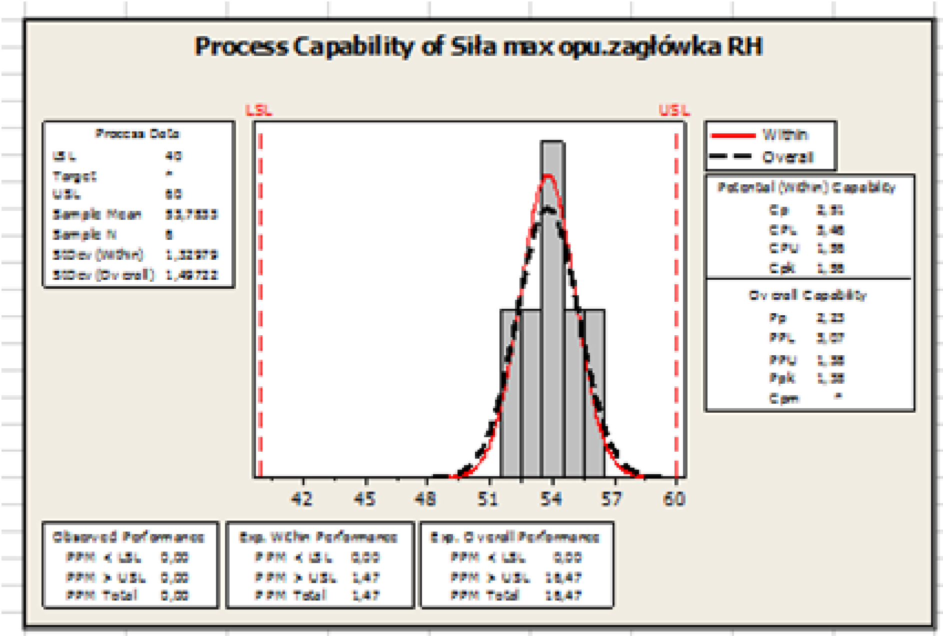

Fig. 5. The maximum friction force achieved during the head restraint displacement down.

5. The most common causes of defects

The research indicates that the most frequent causes of defects are the following: "human error" (defective assembly), defective semi-finished product received from the supplier. The causes of defects are presented in the "fish bone" diagram (Fig. 5).

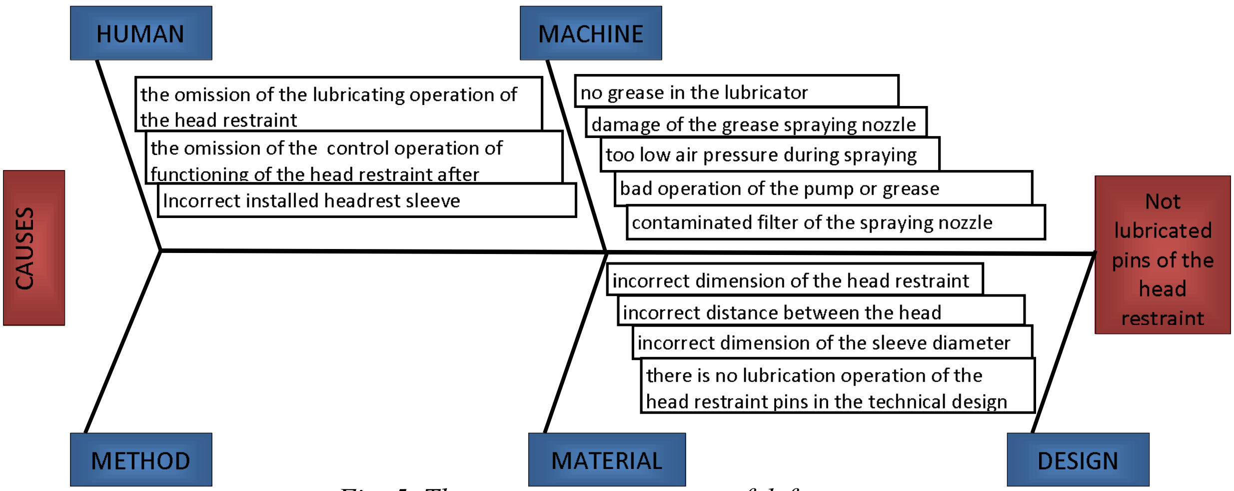

Fig. 5. The most common causes of defects

Each cause for defects is a source of the lack of centering of the process. In order to avoid the most common defects occurrence a Kaizen standard was applied. Every head restraint must be placed in the lubricator otherwise the lighting alarm is activated.

6. Conclusions

The objective of the paper was to evaluate the capability of the measuring process of vertical displacement of the head restraint. In the paper, two techniques of the statistical process control (SPC), namely: histogram and process capability were applied to examine whether a process is statistically controllable and to identify disturbances that occur in the process.

The processes of the head restraint displacement up and down are characterised by a high potential (C_p), but poor centering (a low value of the C_{pk}). In order to improve the centering of the processes, the causes of defects were identified and the Kaizen standard was applied to the most frequent defects. The most frequent defects are the following human errors: the omission of the lubricating operation of the head restraint and the omission of the control operation of functioning of the head restraint after assembly.

Another examples of the techniques of the statistical process control application are in [1]. Another techniques used to evaluate the process capability are presented in [2, 3].

References

1. Wosik I, Zdanek M.: System Six Sigma – studium przypadku, tom 2, Opole 2010, s. 669 – 678 (red.: Ryszard Knosala).
2. Paprocka Iwona, Cyba Sonia: Assessment of Production Capacity and Ability of Rapid Response to Changing Customer Expectations. Applied Mechanics and Materials, *vo.* 809-810 (2015) pp 1378-1383.
3. Paprocka, I; Kempa, W.; Kalinowski, K.; et al. (2015): Estimation of overall equipment effectiveness using simulation programme. Materials Science and Engineering Volume: 95 , Article Number: 012155.
4. M. Kano, S. Hasebe, I. Hashimoto, H. Ohno: Evolution of multivariate statistical process control: application of independent component analysis and external analysis. (Computers & Chemical Engineering, vo. 28 (2004), pp. 1157-1166.