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THE IMPACT OF ALIGNMENT CONDITION IN THE MEASURING PLAN BY USING THE SOFTWARE CALYPSO ON THE REPEATABILITY OF MEASURED VALUES

Zdenko GUNIŠ, Augustín GÖRÖG, Juraj VAGOVSKÝ

ABSTRACT

The main goal of this publication is to determine the impact of the alignment condition to the repeatability of measured values. In the experimental work were performed four series of measurements, each contains 25 individual measurements on a single component. The component was measured according to the rules for making the comparison of measured values for repeatability. This comparison of measurement results was made by using statistical methods. A given goal was completely fulfilled. Experimental work has shown a dominant impact of the alignment condition on the measured values.

KEY WORDS

CMM, repeatability, valueA, standard deviation

INTRODUCTION

In practice, it is necessary to evaluate the capability of the measuring device of process. Nowadays, many companies in the industry use the coordinate measuring machines for measuring of the geometrical characteristics. The question is, whether this device is or is not able to perform a repeated measurement without different measured values on the same component and with the same conditions. The evaluation of the measurement process plays a very important role especially because of bringing the variability to the manufacturing process. If the measurement is correct, and the made component is declared to be defective, then it has an economic consequences. Measuring plans for Coordinate Measuring Machines (CMM) are in present made by using of CAD software that is linked directly to the measuring device. The measuring plan must take steps that will eliminate the fluctuations in the measured values of the measuring plan. These steps will be described in the next section. However, despite of the great accuracy and universality of the gauge, we can't prevent the errors in measurement. An important factor in the evaluation process is evaluation of the measurement repeatability of measurement results. The standard defines repeatability as a closeness conformity between the results of measurements which were obtained in the same

Zdenko GUNIŠ, Augustín GÖRÖG, Juraj VAGOVSKÝ - Slovak University of Technology, Faculty of Materials Science and Technology, Paulínska 16, 917 24 Trnava, Slovak Republic
guniszdenko@gmail.com

object, carried out under the conditions of repeatability; these are the same measurement procedure, using the same measuring equipment, measurement with the same operator, the same measurement place and conditions of environment during measuring and short time intervals between measurements. Repeatability is possible to quantify by the characteristics of the precision results. Precision is the closeness of agreement between independent results, which were conducted under the specified conditions, in another words we can say under the conditions of repeatability. Thus the repeatability of results relates to the precision of the measured values around the average value. It may be expressed, for example by standard deviation. Accuracy is the tightness of the conformity between the results of measuring the same quantity, carried out under the same conditions towards the accepted reference value, that is towards the true value.

THE DEFINITION OF THE PROBLEM

The creation of measuring plan is submitted to a sequence of steps. First, we have to know what we want to measure, which measuring devices we use, what elements we use to define the coordinate system components. They're so called reference elements, which should be produced on the components with maximum accuracy. These elements are also used in focusing and aligning of components. Nowadays, the measurement is executed by using CAD model, which carries the reference (nominal) values, or dimensional shape characteristics. This CAD model includes these elements (planes, cylinders, cones etc.) which have a perfect shape and size and the creation of the measuring plan comprises basically from the first step in establishing nominal values of measured characteristics. For the creation of coordinate system are used bases contained in the drawing documentation, according which is the component focusing on the desk CMM. If we create a coordinate system from the elements which are contained in the CAD model, then is this coordinate system considered as a reference for measuring plan. On these surfaces will be the component focused also in real measurement. If we want to measure a component on the desktop, first we need to measure the component manually, it means that each elements have to be scanned by minimum number of points to define the substitute geometry. Subsequently the software calculates in its internal algorithm a shifting and tilting of the actual coordinate system towards the reference system and it starts a CNC mode. The scanning is in CNC. Here begins a certain issue. Component is scanned but aligning within it contains some error defined as valueA. This means that the actual coordinate system is shifted and tilted towards the nominal about some specific amount. Does this valueA an impact on the further course of measurements and affects the measured values? How do we can eliminate this error in the measurement process to cause the minimal impact on the test result? In a present day exists a PCM condition, that is inserted into the measuring plan, and that can repeats the alignment until the valueA isn't minimized. This means, that the measurement does not start in CNC mode while this value is less or equal to the maximum permissible value in the condition of alignment. Nowadays is this condition used only in certain cases or not, because it extends the time of measurement. The usage is limited mainly because of the ignorance of the impact of this condition on the result of measurement, repeatability of measured values and capability of measurement process. Therefore, the goal of the experimental work was to determine the impact of the conditions on the repeatability of the measured values and clearly confirm or deny its impact (TŮMOVÁ 2009, ISO/WD 15725-1).

CONDITIONS OF MEASUREMENT

For the realization of the experimental work was chosen the coordinate measuring machine DURAMAX (ZEISS), which uses contacting scanning head VAST XXT TL-3. Measured component was proposed on the base of the shape demands, then we can measure various geometrical characteristics of it. For the creation of a measuring plan has served to us a measuring and evaluation software CALYPSO 5.4, where measuring plan was created. For the simplification of programming was used CAD model of components in a STL format. To create a coordinate system of component were used bases, that are included in the drawing documentation. The component was measured on these surfaces and in measuring plan was gradually changed the condition of aligning. The measurement parameters were set (the tracks of scanning points, stride length, movement speed of touch probe). To determine the impact of the alignment condition for the repeatability of measured values was suggested the following procedure. The first series of measurements was performed without entering the alignment condition. The component was clamped to the preparation and measurement took a place of defined characteristics. In a second series of measurements was into the measuring plan entered the condition as baseSystem(). valueA≤0.5. In the third series of measurement, this condition was defined as baseSystem ().valueA≤0.05 and in the fourth was used the baseSystem().valueA≤0005. The characteristics that were evaluated are valid according to STN EN ISO 1101:2006 – Geometrical Product Specifications GPS. These characteristics were set according to tolerance of drawing documentation. To evaluate the repeatability of the measured values was necessary to release and re-clamped component from the preparation. The component was measured in each series 25 times. Repeatability was evaluated graphically and numerically (median, standard deviation, precision of measured values).

MEASURED VALUES AND THEIR EVALUATION

The measurement was kept to the laboratory terms. The temperature of environment was 20 °C this means that the maximum permissible error of the machine in the range of temperature 18-22 °C is the MPEE = (2.4 + L/300) mm.

From the drawing documentation were chosen the characteristics, which served for comparison of the alignment impact on the repeatability of measured values. The first measurement was made without the condition of alignment, subsequently, after the first series of 25 measurements was into the CNC program gradually inserted the condition of alignment valueA<0.5, valueA<0.05 and valueA<0.005. The course of measured values can be seen in the following figures. For the comparison were chosen some characteristics. Course of the measured values for the measurement of distance is in Fig. 1, here can be clearly seen more stable values by using the alignment conditions in comparison with the measurements where this condition wasn't used. The total difference can be seen in the standard deviation in Fig. 2.

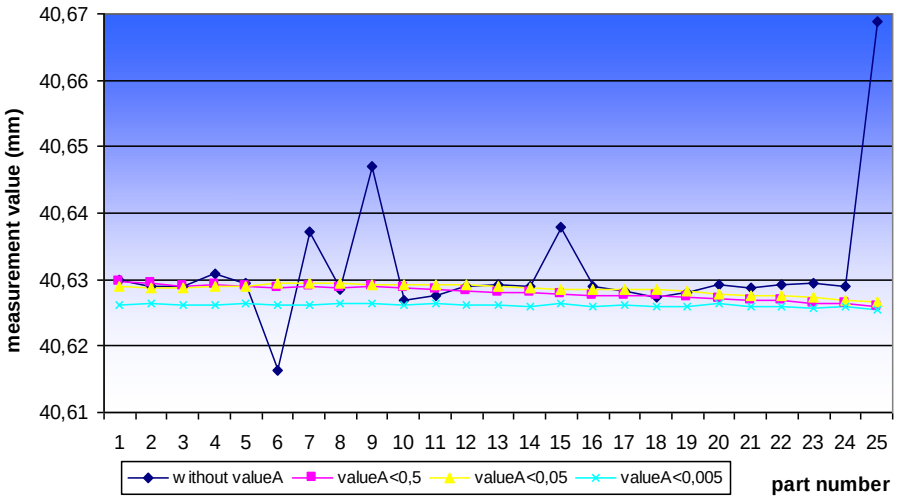

Fig. 1 *The course of measured values for DIS_40,63mm*

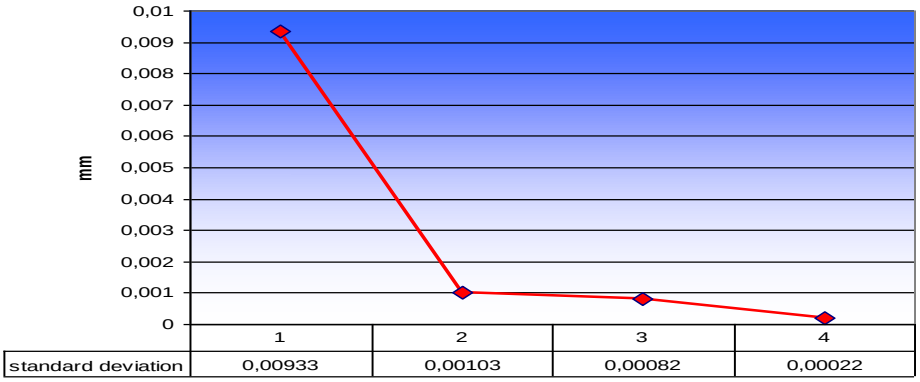

Fig. 2 Standard deviation of measured values for DIS_40,63

The next from the measured characteristics was the axial runout. Here we can see a noticeable difference between the measured values with using the alignment condition and without the alignment condition. The course of the measured values is shown in Fig. 3 and the resultant standard deviation is shown in Fig. 4.

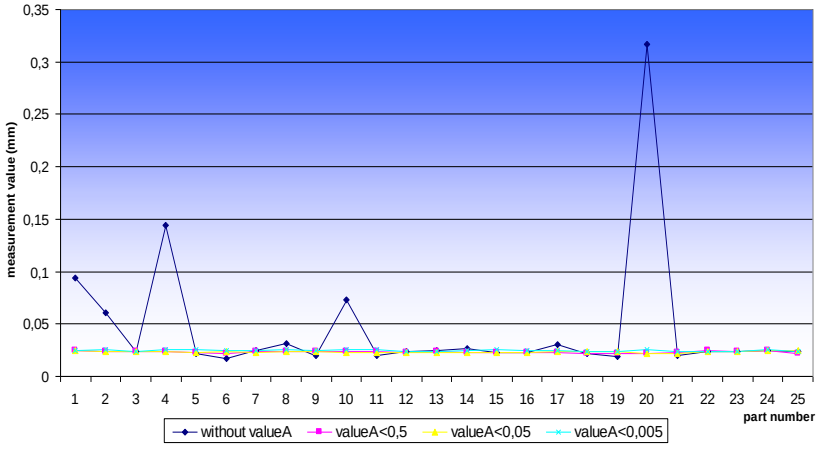

Fig. 3 *The course of measured values axial runout*

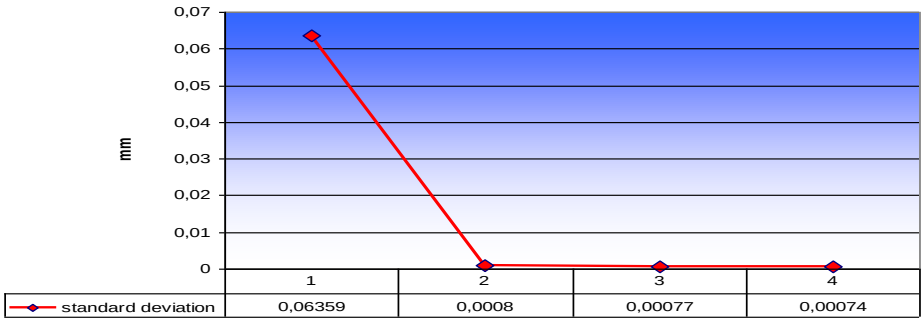

Fig. 4 *Standard deviation of measured values for the axial runout*

Significant difference between the measured values was especially shown in characteristics that are difficult to measure. It was a complex component shapes, and some characteristics were evaluated from the elements, because they could not be measured as a whole. Such elements have also been used when evaluating the parallelity, and its results are shown in Fig. 5. The standard deviation had a downward trend with applying the flatness conditions (Fig. 6).

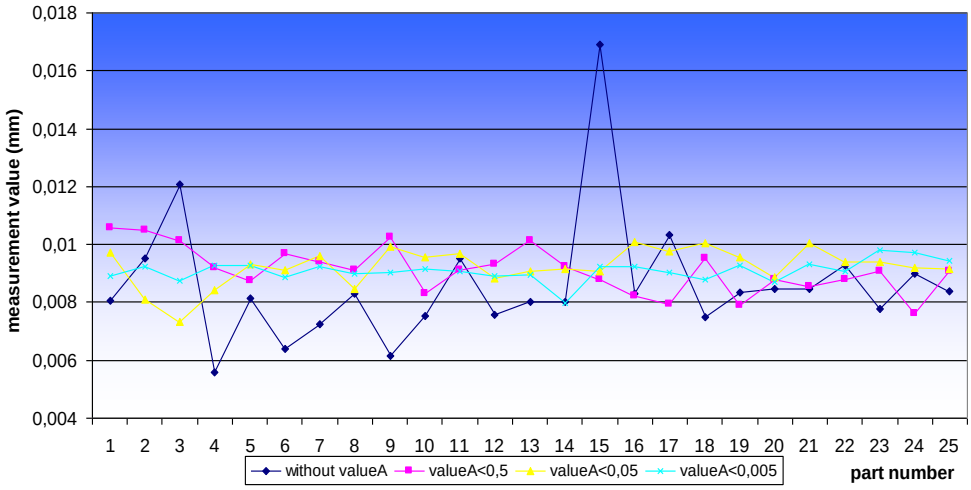

Fig. 5 *The course of measured values when measuring parallelism*

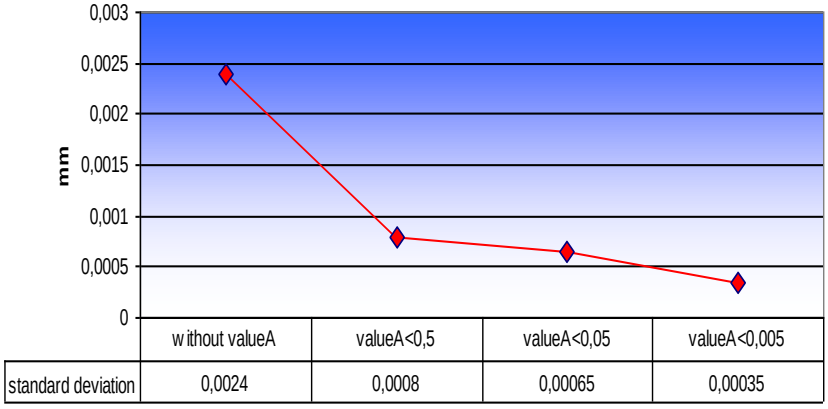

Fig. 6 *Standard deviation of measured values for parallelism*

CONCLUSION

It is often impossible to clamp a complex shape components into the products, where is guaranteed the repeatability with high accuracy. Therefore the experimental work was conducted to assess the impact of alignment condition on the repeatability of measured values. With decreasing of the valueA was the standard deviation of the measured values varied significantly what can be seen in these figures. The measurement results clearly demonstrate the impact of alignment conditions on the repeatability of the measured values, which has important and essential meaning in practice. The scores very clearly demonstrate, that if we want to measure in serial measurements, where it is not possible to use the preparation with guaranteed repeatability of clamping, it is necessary to insert the alignment condition into the measuring plan. The value into which the part is aligning (valueA) should be specified according to the smallest defined tolerances in the drawing documentation. This issue requires a big consideration, because the coordinate measuring technique is widely used in practice. To further determination of the impact on the measured values will be necessary to apply the obtained knowledge on the component, which can be regarded as a standard. It is necessary mainly from the reason of the determination the impact of this condition on the accuracy of measured values.

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