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Effect of the Workpiece Position on the Manufacturing Tolerances

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***Abstract*—**Manufacturing tolerancing is intended to determine the intermediate geometrical and dimensional states of the part during its manufacturing process. These manufacturing dimensions also serve to satisfy not only the functional requirements given in the definition drawing, but also the manufacturing constraints, for example geometrical defects of the machine, vibration and the wear of the cutting tool.

The choice of positioning has an important influence on the cost and quality of manufacture. To avoid this problem, a two-step approach has been developed. The first step is dedicated to the determination of the optimum position. As for the second step, a study was carried out for the tightening effect on the tolerance interval.

***Keywords*—**Dispersion, tolerance, manufacturing, position.

I. Introduction

THE precision exploits a central role the competition of the modern companies. In the field of manufacture, the realization of the parts is unit or in series with same precision i.e. with same dimensions is impossible. This inevitable inaccuracy is due to several factors such as the error of setting in position, the vibrations, the wear of the tool during machining, positioning of the stops. In the technical literature, these factors called dispersions of machinings and which are division in two dispersions, random dispersion and systematic dispersion

Many research works were treated the tolerancing problem with different approaches; [1] proposed a system called AUTOFIX which allows to conceive the manufacturing assembly from the geometry of the part and the organization of the phase. Perremans [2] has developed a system called IDEFIX computer for performing the design of all the fixtures required for the manufacture of a prismatic part. Rong and Bai [3] analyzed a dependent relationship of operational dimensions to estimate machining errors in terms of linear and angular dimensions of a workpiece. Cai et al. [4] proposed a method to conduct a robust fixture design to minimize workpiece positional errors as a result of workpiece surface and fixture setup errors. Djurdjanovic and Ni [5] developed procedures for determining the influence of errors in fixtures, locating datum features and measurement datum features on dimensional errors in machining. These studies were conducted when a static case was assumed. Hirsch [6] proposed a system called MCOES to design a machine assembly ensuring taking part in the assembly of the parts belonging to a family of parts. For each family, the user interactively designs a machine for mounting a spare this family. In the work of [7], a study was presented on the influence of the position of the cutting tool on the dynamic behavior in thin wall milling, and in the work of [8]-[10] the authors illustrate the influence of the path of the cutting tool on the surface. The work of [11] is to study the influence of the systematic dispersion on manufacturing tolerances. Sebaa [12] proposed a mathematical model to calculate the distribution of Fulcrums.

Our work is fixed on the influence of the dispersion of the positioning on the manufacturing tolerances.

II. Experimental Study

The purpose of this part is to study the influence of the error of the positioning on the manufacturing tolerances. To achieve this, two steps are developed.

A. First Step

The purpose of this step is the determination of the optimal position isostatic. To achieve this goal, we conducted a test of 100 trials as illustrated in Fig. 1. Fig. 2 shows an example of measurement.

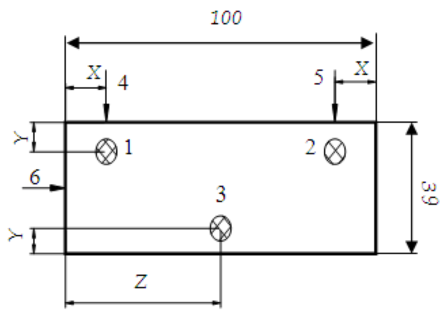

Fig. 1 Fulcrums variation

Fig. 2 Example of measurement

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Fig. 3 shows the evolution of the standard deviations of the Fulcrum 1 according to the number of trials. The selected positions vary between 0.002 and 0.014. Then, the position 9 is the optimal position for Fulcrum 1.

Fig. 4 shows the evolution of the standard deviations of the Fulcrum 2 according to the number of trials. The selected positions vary between 0.003 and 0.012. Then, the position 10 is the optimal position for Fulcrum 2.

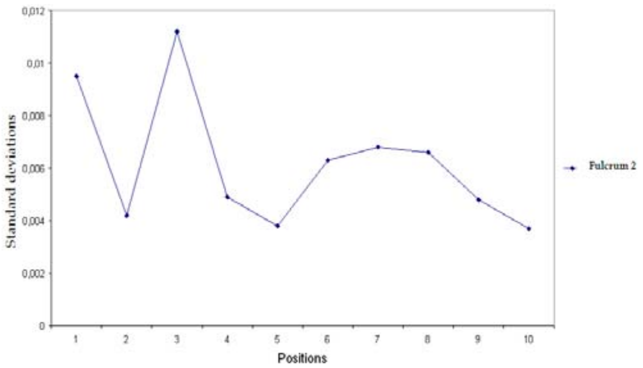

Fig. 3 Standard deviations of the Fulcrum 1 according to the number of trials

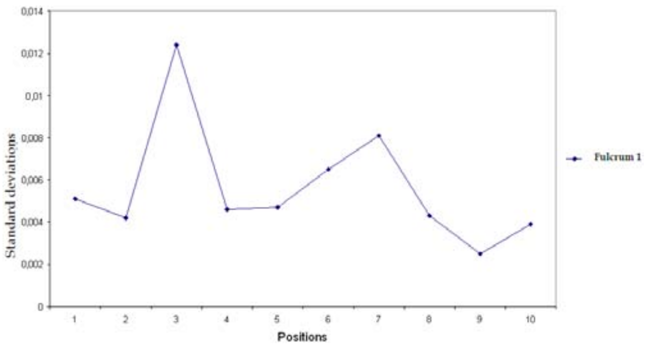

Fig. 4 Standard deviations of the Fulcrum 2 according to the number of trials

Fig. 5 shows the evolution of the standard deviations of the Fulcrum 3 according to the number of trials. The selected positions vary between 0.0025 and 0.012. Then, the position 6 is the optimal position for Fulcrum 3.

Fig. 6 shows the evolution of the standard deviations of the Fulcrum 4 according to the number of trials. The selected positions vary between 0.002 and 0.035. Then, the position 10 is the optimal position for Fulcrum 4.

Fig. 7 shows the evolution of the standard deviations of the Fulcrum 5 according to the number of trials. The selected positions vary between 0.002 and 0.035. Then, the position 10 is the optimal position for Fulcrum 5.

Fig. 8 shows the evolution of the standard deviations of the Fulcrum 5 according to the number of trials. The selected positions vary between 0 and 0.035. Then, the optimal position is given by the positions 3, 8 and 10.

According to the graphs represented in Figs. 3-8, we deduct the distribution from it of Fulcrum optimal so as to find the slightest error. Fig. 9 represents the optimal distribution.

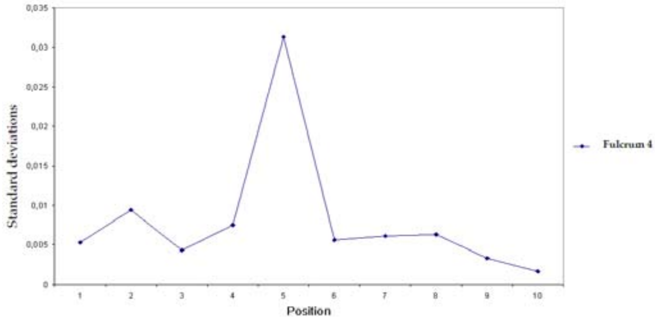

Fig. 5 Standard deviations of the Fulcrum 3 according to the number of trials

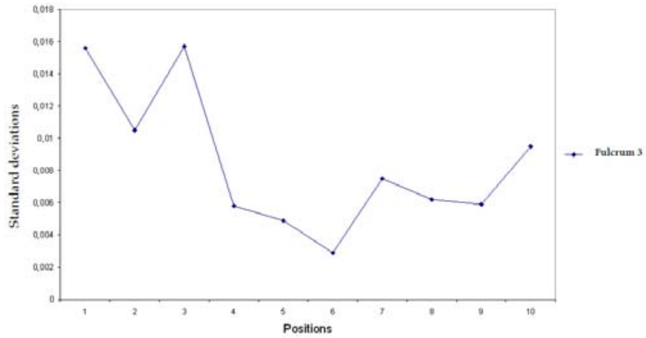

Fig. 6 Standard deviations of the Fulcrum 4 according to the number of trials

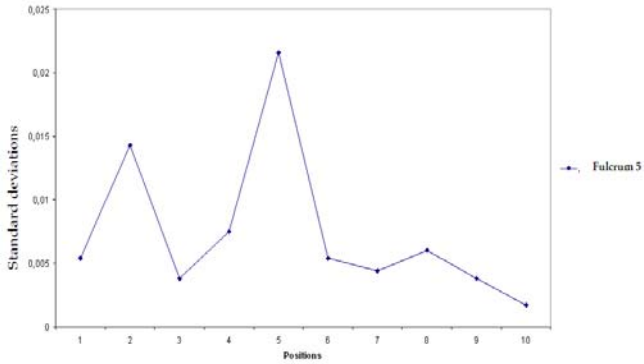

Fig. 7 Standard deviations of the Fulcrum 5 according to the number of trials

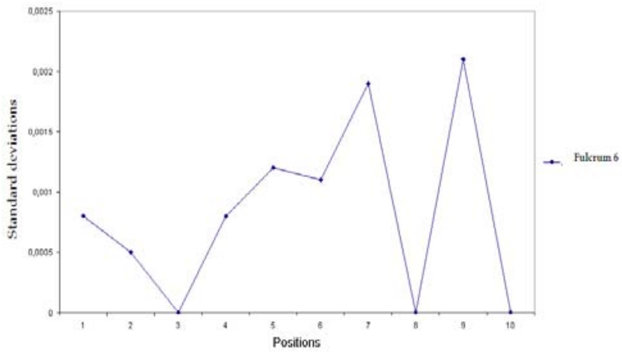

Fig. 8 Standard deviations of the Fulcrum 6 according to the number of trials

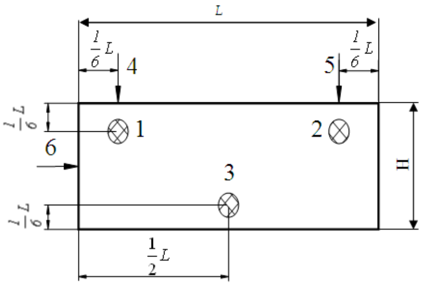

Fig. 9 Optimal position

B. Second Step

In this stage of ten tries, we measure the defects of putting in position under the influence of tightening and we calculate the standard deviations of every Fulcrum. We measure the defects for every tightening by using the optimal position.

Fig. 10 shows an example of measure of the defects with tightening.

Fig. 10 Example of measurement

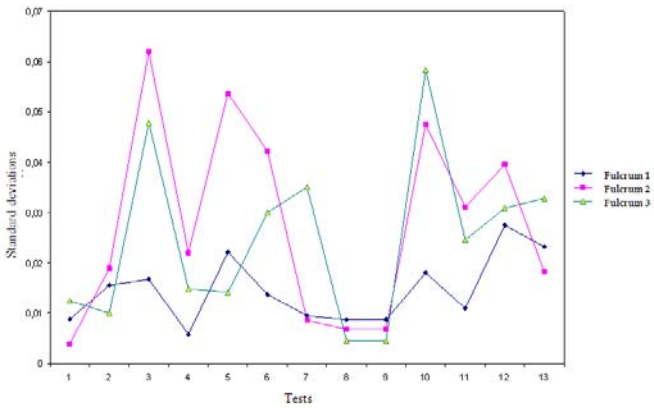

Fig. 11 Standard deviations of the Fulcrum plan under the influence of tightening according to the trial number

Fig. 11 shows the evolution of the standard deviation of the Fulcrums plan defined by the Fulcrums 1, 2, and 3 according to the trial number.

According to the graphs (Fig. 11), we notice that in the majority of the positions, Fulcrum 2 and Fulcrum 3 carry important errors.

Fig. 12 illustrates the evolution of the standard deviation of the linear Fulcrum defined by the Fulcrums 4 and 5 according to the trial number. We notice both graphs, due to the phenomenon of tightening of both Fulcrums 4 and 5, are parallel.

Fig. 13 illustrates the evolution of the standard deviation of the punctual Fulcrum (6) according to the trial number. We notice that the graph of the Fulcrum 6 is always null; this phenomenon is due to the punctual contact of the Fulcrum.

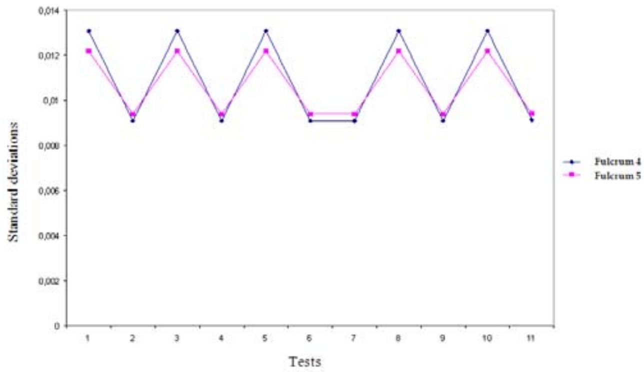

Fig. 12 Standard deviations of the linear Fulcrum under the influence of tightening

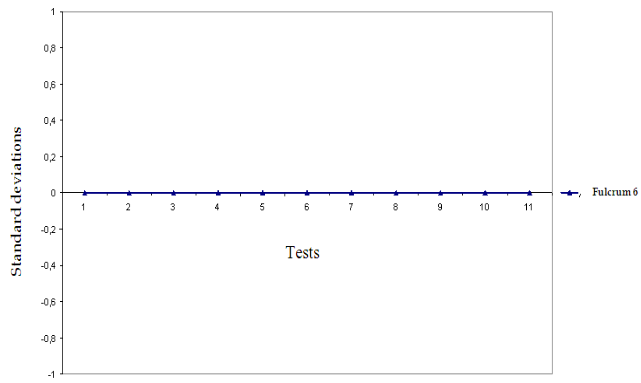

Fig. 13 Standard deviations of the punctual fulcrum under the influence of tightening

III. Conclusion

In this paper, we presented two stages to calculate the dispersal of the putting in position as well as influence them on the manufacturing tolerances. It emerges from it that the optimal distribution of the Fulcrums made in the following way; 1/6 for the Fulcrums 1, 2, 3, 4 et5, 1/2 for the Fulcrum 6. Even with the optimal allocation we noticed that the effect of the tightening in an important influence on the quality of parts.

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