7th International DAAAM Baltic Conference
"INDUSTRIAL ENGINEERING”
22-24 April 2010, Tallinn, Estonia

AIDED BY COMPUTER OPTIMISATION FOR QUALITY INSPECTION METHODS

Braun, B.; Motoc, L.; Olteanu, C.; Zamfira, S.

Abstract: *The paper presents the way in which the quality control process can be optimized due to the analysis of different used methods. The methods refer not only to the different types of quality inspection equipments but especially to the ways in which the control process was obtained.*
The quality process optimization invokes as first step to demonstrate which method for the control is the better, taking into account different criteria, like: costs, productivity and process quality. The optimization is important not only to take a correct decision about the proper quality control process method by all the points of view, but especially to reduce the necessary time and costs just on the choosing phase of the quality control process.
Key words: quality, Lab VIEW, device, optimization

1. CONTROL PROCESS OPTIMIZATION CONCEPT

Due to the fact that the manufacturing process must satisfy different important and strict criteria, we have referred to the control process as a critical technological operation. Being an important way to ensure the high qualitative finite product, the control process must be adequate by different points of view: costs, precision, efficiency, energy consumption. For this reason, we took the problem to optimize the process not only to increase the efficiency and finite product quality but also to reduce the manufacturing process costs and energy consumption.

2. THE RESEARCH OBJECT

Our study about the control process ensuring was concentrated on the dimensional inspection of some probes as finite product components. First of all it is about the probes who execute rotation or translation movements, like: bearings, wheels, guiding and so on. On the optimization, our research reason was to develop a rapid and low cost method to establish the ideal method to perform the dimensional inspection as quality control. In fact, our study refers to demonstrate which method for the control is the better, taking into account different criteria, like: costs, productivity and process quality. To find a good solution to optimize the dimensional inspection, first of all we have made a study for two types of tested probes: the first is a flywheel who equips the distribution mechanism used for the hard autos. The second type of tested probe was guidance rail used for the hard manufacturing machines (figure 1).

Fig.1. The tested probes used for our study

The control process for each tested probe was made with different dimensional measuring devices to evaluate the performances for each one. Beside, the dimensional inspection was made in different conditions, referring to the probe's entraining mode during the control process. The manual mode consisted into the form deviation of the probe, measured in a finite number of equidistant points. Experimentally we found that the manual mode was the most accurate by the point of view of precision. For this reason we considered the manual mode as reference for the most accurate dimensional inspection. The automatic mode invoked different entraining speeds of the tested probes during the control process, the accuracy results being reported to the in static mode results. Considering both inspection accuracy and process efficiency we stabled two main criteria for the methods and devices used on the dimensional inspection. Beside we took into account the cost for each measuring device. Having all the experimental information on two fundamental types of finite product components, we continued the research on the establishing of an algorithm to find the optimum solution to perform the dimensional inspection for both studied probes.

3. SOFTWARE APPLICATION TO ENSURE THE CONTROL PROCESS OPTIMIZATION

To find a viable solution to optimize the dimensional inspection for both tested probes, we developed an application in the Lab VIEW software environment enable to inform any user about the better control process method, immediately after the method conditions are specified as inputs. The obtained measuring results were considered as inputs for the software application. To run it, the user have to proceed to: 1 - the specifying of the necessary conditions to insure the dimensional inspection process, 2 - the aided by computer dimensional inspection optimization criteria, 3 - the specifying of the necessary costs of each used control device as quality insurance method. In figure 2 there are presented the type of tested probe and the measuring conditions that must be entered into the interface. There are taken into account 4 types of measuring devices to be evaluated.

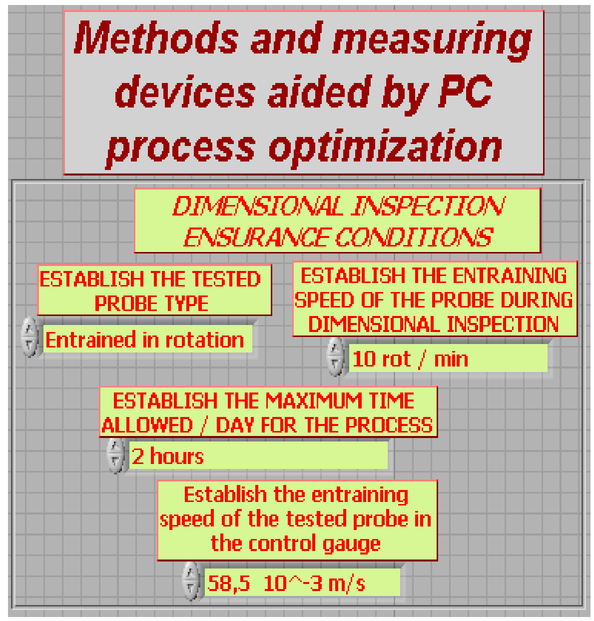

Fig. 2 The dimensional inspection conditions specifying

The panel interface presented in figure 2 contains *Text Ring* controls having a selective character. Each control addresses a multi-case programming structure, each case corresponding to an option to choose by the user (figure 3).

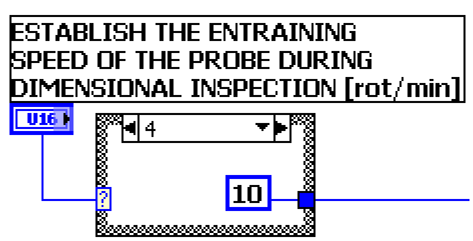

Fig.3. The programming Text Ring selectors to establish the measuring conditions

The main optimization criteria were established into the panel presented below, referring to the measurement productivity and accuracy.

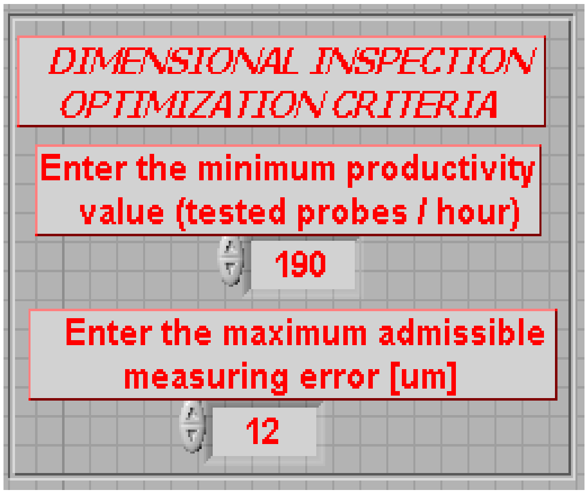

Fig.3. The main criteria on the dimensional inspection optimization

For each type of measuring device, the determined functioning parameter, as numeric indicator was compared with the imposed values as limits on the criteria like efficiency and measurement accuracy. For example if the determined measuring accuracy of a device is smaller than the maximum admissible measuring accuracy, it satisfies the precision criteria. This comparison was transposed into the Lab VIEW application via two *Comparison* functions which output are cumulated with an *AND* logic function. Its output activates a state led indicating if the tested measuring transducer corresponds by the point of view of measuring accuracy (figure 4). The first input who addresses the *AND* function refers to the comparison between the maximum admissible measuring error. The second input represents the output of the comparison between the maximum admissible and the effective surface's probe deformation for a constant applying measuring force (figure 4). The maximum admissible probe's surface deformation caused by the contact with the measuring device during the control process can be established depending by the probe's destination into the finite product.

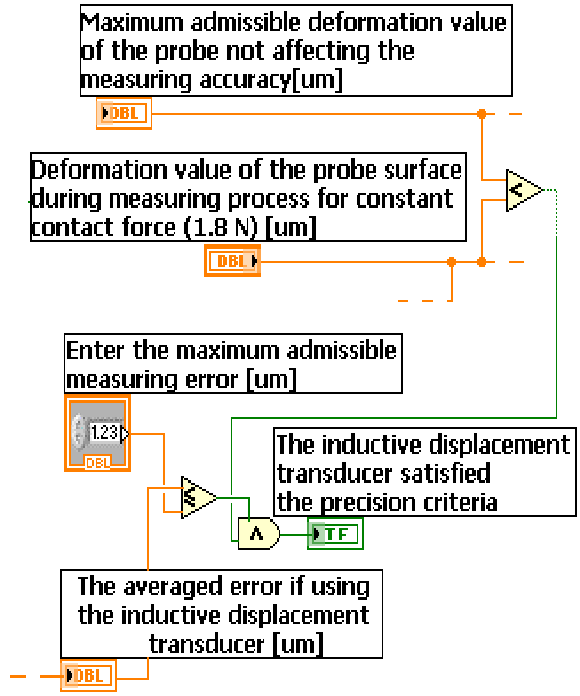

Fig.4. The programming algorithm to evaluate one of the measuring devices by the point of view of precision.

For each measuring device, the measuring accuracy was determinate due to some experimental results on the statistical measuring accuracy. To calculate the accuracy value in case of the use of each measuring device, there was programmed the following algorithm: The experimental results were read from an EXCEL converted to a .txt file, due to a *Read from spreadsheet file*, the output being a numeric vector referring to the errors determinate previously when a probe surface was scanned in N equidistant points. N represents the number of elements which compose the vector. So the N measuring error values were averaged, due to a FOR-LOOP structure with N iterations (figure 5). The same algorithm was applied for each of the tested measuring devices.

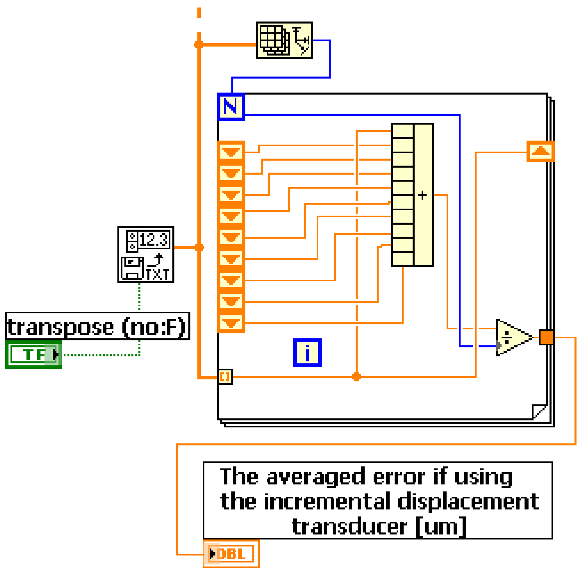

Fig.5 The programming of the algorithm to determine the measuring errors for each measuring device

Another criteria refeers to the measuring devices costs, which are estimated by the user (figure 6).

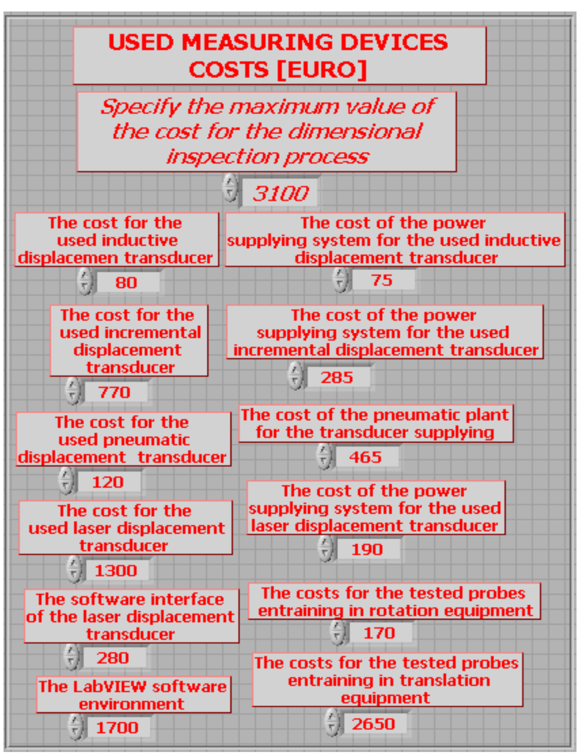

Fig. 6. The specified costs for the used measuring devices

The efficiency criterion is defined as productivity values regarding the control process, depending by the manufacturing productivity and also by the number of probes (or components) to be measured (figure 7).

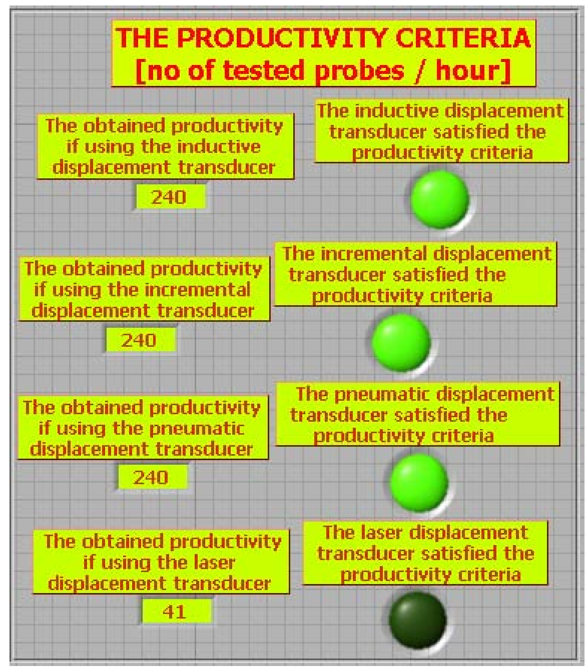

Fig.7. The results on the productivity criteria for each used measuring device

The programming algorithm to evaluate each measuring device by the point of view of efficiency is similar to the algorithm on the accuracy.

After specifying of all input parameters, the application can be run to obtain all the necessary information about the results for each used method. The obtained data refers first of all to the demonstrated performances by the point of view of efficiency for different dimensional inspection conditions, like tested probe entraining speed. The precision results for different applied dimensional measuring device are also obtained, it being very useful information to choose the proper equipment for the control, taking into account also the obtained data about the optimal process condition. About the productivity, there were obtained the

information for each of the used devices (figure 7).
On the measuring accuracy for each of the used device, the results can be observed in the figure 8.

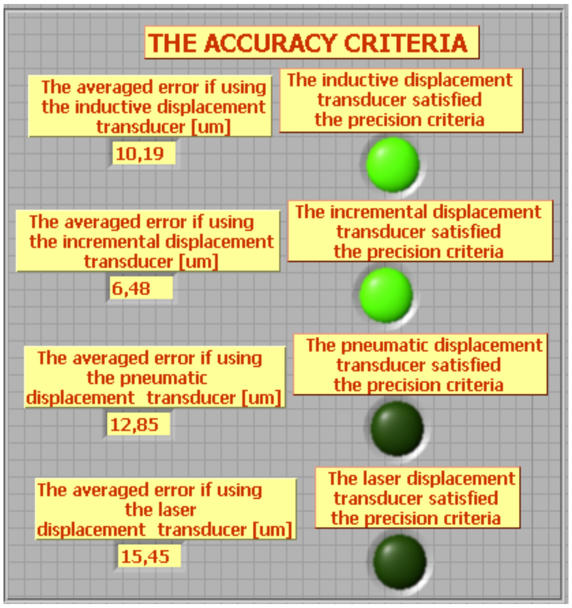

Fig.8. The results on the accuracy criteria for the used measuring devices

The software application allowed also the evaluating of the used measuring devices by the point of view of costs, as it can be seen in figure 9.
About the displacement inspection used methods, the software application proved to be very useful, the dynamic parameters results in case of measuring automatic mode being observed (figure 8.)
Regarding the measuring devices evaluating taking into account the tested probes entraining speed, there were considered two main aspects: the determinate control productivity obtained with each measuring device for all probe's entraining speeds to which the probes were dimensionally tested and also the statistic measuring errors for each entraining speed. For each entraining speed we determinate the data on the measuring accuracy experimentally, it being extracted from a file to be processed in the Lab VIEW application. Combining the two algorithms on the accuracy and efficiency criteria, by running the program, there it could be obtained the information on the optimum measuring device by the point of view of the tested probes entraining speed (figure 10).

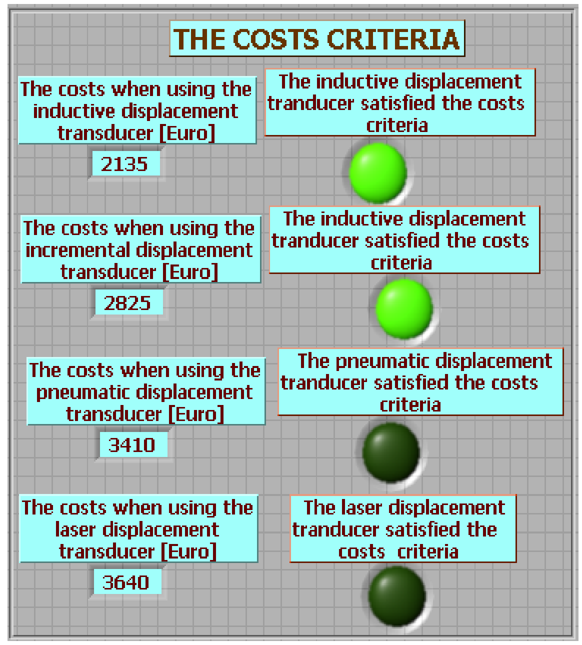

Fig.9. The results about the necessary costs for each used measuring device

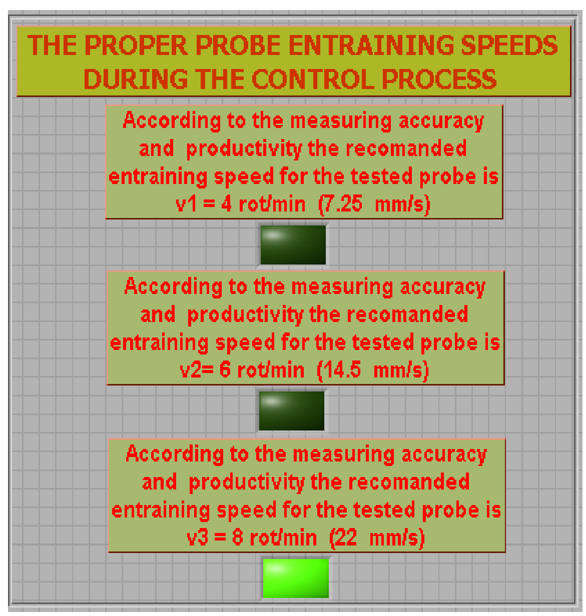

Fig. 10. The results about the proper entraining speed

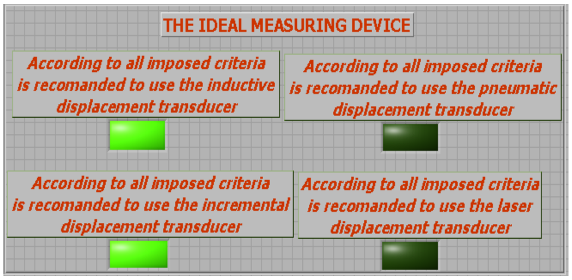

Fig.11. The aided by PC recommended optimum measuring device to satisfy all the quality control exigencies

By synthesizing the partial results on each criteria, the application succeeded to generate the final information regarding the proper measuring device, including all the imposed criteria (accuracy, efficiency and costs) (Figure 11).

4. CONCLUSION

The proposed solution has a post process character due to the fact that the input data refer to the specified conditions applied in different practical experiments on the dimensional control. It serve to have a very quickly and completely statistics about all the conditions invoked by every used method for the quality control. The software application is flexible, due to the fact that it takes into account a very large domain of dimensional measuring conditions and used devices.

5. REFERENCES

1. Braun, B. - *The virtual instrumentation in the dimensional control 2nd part* - Buletinul Univ. TRANSILVANIA Brasov, 2006, vol. 13(48), New Series, Series A, ISSN 1223 - 9631;

2. Braun, B.; Costaş, Cristina; Drugă, C. - *The virtual instrumentation in the automatic dimensional control process optimization*, 6th International DAAAM Baltic Conference INDUSTRIAL ENGINEERING, 24-26 april 2008, Tallinn, Estonia, ISBN 978-9985-59-783-5;

3. Braun, B.; Drugă, C.; Costaş, Cristina. - *The experimental determining of the dynamic dimensional control about the measuring precision*, 6th International DAAAM Baltic Conference INDUSTRIAL ENGINEERING 24-26 april 2008, Tallinn, Estonia;