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MACHINE GAGING PHILOSOPHY ON INSTRUMENTATION

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REP-670

MACHINE GAGING PHILOSOPHY ON INSTRUMENTATION *

L. W. Grote

The ultimate goal of all production and quality activities is to produce a part to the desired quality level; at the desired production rate; prove that, or be reasonably sure that the desired quality level has been obtained with a minimum investment of time, men, money, and machines. How this is accomplished will vary widely from plant to plant or product to product. Where high precision fabrication machines of known reliability equipped with feed-back devices and servo-systems are employed in the manufacturing cycle there is a temptation to use these machine tools for both fabrication and inspection.

Before this decision can be made, the economic and technical factors involved must be thoroughly analyzed.

The primary reason to consider a machine tool and a separate gage vs a machine tool-gage combination is the initial cost, the operating costs, and the accuracy obtained. From the operating cost standpoint the machine tool-gage combination will be less productive than a separate machine tool and gage. The actual magnitude can be calculated by adding the standard time for each of the operations and comparing the totals.

A complicated part, with both internal and external cuts, will experience more gage set-up time in a machine tool-gage combination than with a separate machine and gage due to the inability to caliper the part and inspect multi-dimensions simultaneously.

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The operating cost of the machine tool-gage combination will be greater than a separate machine tool and gage setup. The when and where of the break-even point, due to the savings on the initial investment, would have to be calculated in each case on its own merits.

The machine tool-gage combination net production rate is determined by the single longest operation, or by the limitation of the least efficient unit on the machine tool-gage combination. Looking at the technical side of the problem the following elements would be common to both the machine tool and the gage of a machine tool-gage combination.

1. Part locating method.
2. Part clamping method.
3. Spindle.
4. Slide ways.
5. Positioning system.
6. Environment.

The gage, therefore, could not detect spindle axial and radial run-out, slide geometry errors, the perpendicularity of the slides, the positioning errors or environmental errors. In addition, the part is gaged under the influence of the locating and clamping conditions of the machine tool. The inspection results obtained from measuring the same part in a free and unsupported state could vary widely from the data obtained when it was measured under the influence of locating and clamping fixture of the machine tool.

In some cases, parts experience a dimensional change after machining due to residual stresses and temperature generated by the cutting process. Immediately after these parts have been machined is not the opportune time to inspect them, nor can the machine tool-gage combination be tied up for extended periods of time waiting for a part to reach dimensional stability. Another inherent disadvantage to the machine tool-gage combination is the inability to gage the relationship of internal to external dimensions in one setup. Down time is another factor that must be taken into consideration. Any routine service maintenance or emergency repair on the machine tool-gage combination will take both a machine tool and a gage out of service which is another inherent disadvantage.

If the overall production rate requires the purchase of several machine tool-gage combinations the advantages of the machine tool-gage combination are rapidly lost.

From the foregoing analysis it appears in the majority of cases there are more disadvantages to the machine tool-gage combination than to the separate machine and gage system.

At the second meeting of IMOG held January 10 & 11, 1962, Agenda Item #16 - On The Machine Inspection - as taken from the minutes:

In the general discussion it was agreed that as of now, on-the-machine dimensional inspection cannot be taken as final buy-off data. However, the time may come when in-process inspection could be done at time of machining.

The subject of on-machine inspection covers such a large field it is rather difficult to know just where to start - the reason being there are so many types of machines: lathes, mills, grinders, which in turn use cutting oils and coolants, not to mention the grit produced by grinders. These items in themselves create many problems.

To further explore the possibilities of on-machine inspection, Mr. Wendeln, Mr. Weems, and myself attended the Machine Tool Show in Chicago in September 65. This did not produce any new ideas.

Considerable progress has been made since 1962 in both the machining and gaging fields, and at the same time parts tolerances have been getting tighter and tighter - so today we find ourselves not a bit closer to realization of on-machine inspection of parts.

One solution to the problem would be the use of a process capability study of a given process to determine its ability to produce a part to the desired specification.

The use of a simplified inspection criteria and control chart technique could be employed to provide reasonable assurance that the parts are being continuously fabricated by a process that is under control.

The use of these statistical tools will significantly reduce the inspection time and the inspection equipment required to support a high volume production facility and still guarantee the quality of the product being produced.