ASPECTS REGARDING THE INFLUENCE OF THE ATR FUNCTION ON THE MANAGEMENT OF WARE AT THE FLEXIBLE MANUFACTURING SYSTEMS

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ABSTRACT: Flexible manufacturing widely used in the manufacturing industry, but the implementation o a flexible manufacturing system can raise a series of challenges regarding. An area where in the case of flexible manufacturing systems can generate problem and have a significant influence on the production cost is the management of the tool ware. Tool ware can have a significant influence on the cost efficiency of a flexible manufacturing system either trough the high cost of the tool or trough the problems caused the finished pieces during the production process by tools that are not in the specified parameters. The paper will present the main aspects of the tool ware and of the automatic tool rearrangement function, analyze the influence of the ATR in an FMS and present the general aspects of an ART function implementation at the University of Oradea
KEYWORDS: tool ware, flexible manufacturing, tool ware, automatic tool rearrangement

1. INTRODUCTION

Flexibility is defined as the ability of manufacturing systems to adapt to changing manufactured tasks [1].

The main parameters that provide an overview of the performance of a production system are the volume of the realized production, production quality, and cost. However although some of these are purely quantitative parameters and easy to analyze, the large variety of production systems raises a number of challenges in terms of performance evaluation.

As manufacturing companies compete to bring on the market and provide for their costumers a cost effective product at the required standards, the evaluation of a manufacturing system trough costs is an obvious choice.

Tool ware influences in any type of manufacturing systems but starting with the FMS system tool ware is a challenge since it requires special systems and methods to detect tool ware, establish thresholds and limit the influence of tool wear on costs. The cost of production by tool wear is generated trough two main mechanisms. On the first hand tool ware that is managed only trough systems based on theoretical wear could prove as a viable solution but in the case of systems where there is a large number of variables in terms of materials, precision and surface quality required the system could cause either the change of a tool that could generate pieces in the required parameters (thus increasing overall usage of tools) or in some cases could maintain a tool in production (based on the theoretical usage time of the tool) even if the tool is already producing pieces outside the accepted limits.

2. DURABILITY AND CAUSES OF TOOL WEAR

Tool wear is a complex physical-chemical process of destruction of the surface layers of the material tool [2].

Breaking or crushing a portion of the cutting edge - is due to the emergence of forces that overwhelm the cutting edge. This type of damage occurs in the case where the processed material has a high hardness. Another cause of this is the type of wear and disruptions due to defects in material cutting, cutting edge thoroughly crushing the possible re-entry of the processed material [2].

The main causes of the cutting tool wear are:

- Abrasion - The main cause of this type of wear is contact between chip and rake face formed, and contact between the chip and back edges of the tool.
- The buildup of deposits on edge - It appears on the tool rake face and is due to the action of external mechanical forces and the forces of friction when processing materials with plasticity and toughness properties [2].
- Wear by diffusion - Wear by diffusion occurs because of a change of structure and tool material b composition because of the temperature of the cutting process. Diffusion occurs because the molecules get great mobility.

- tool material oxidation - This wear is due to the oxidation reaction of the material of the tool, catalyzed by the phenomenon of the thermal cutting process [2].

3. THE ISSUE OF MONITORING TOOL WEAR IN FLEXIBLE MANUFACTURING SYSTEMS

Tool wear monitoring has a particularly important role in the flexible manufacturing systems. High productivity and production systems where the role of the human operator to directly monitor the production system is significantly reduced can be achieved if there are implemented methods of monitoring tools and methods for determining and avoidance methods for the damage of the cutting tools.

An essential principle of flexible manufacturing systems is that of obtaining a consistent quality of the products. In light of this principle, tool wears monitoring and ensuring their proper management plays an important role. Also, ensure proper operation of the tool within the flexible manufacturing systems can be obtained if there is a system for monitoring wear.

Tool wear monitoring methods are grouped into two broad categories namely direct monitoring tool that indirect monitoring (monitoring parameters directly linked to the wear of the cutting tool). The main direct methods for the determination of tool wear monitoring are linked via real-time video systems. Indirect methods relate to monitoring certain parameters that are influenced by the torque tool wear namely, the advance current drawn by the motor, vibration monitoring, etc.

Determination of tool wear monitoring using torque and forward movement is based on the monitoring of forces in the cutting process. All these methods are based on the cutting forces increase with increasing wear [3].

Tool wear determination using vibration and noise monitoring it is a widespread method for the diagnosis of machine tools, but this method is not as widespread for monitoring tool wear. This is mainly due to the fact that the method is highly sensitive and by their nature of the machining processes are accompanied by high levels of vibration. The main advantage this methods for determination of tool wear using vibration measurement have been the ease of implementation and in particular that there are no additional devices to be installed in the vicinity of the cutting tool, spindle or machine table [4].

Determination of tool wears using ultrasonic vibration monitoring presents a number of advantages over other methods for monitoring wear by monitoring vibration. Low-frequency signals are used to analyze the ultrasonic vibrations are not affected by attenuation or distortions reason transducer can be placed at a greater distance from the tool. In this type of analysis is the common practice of comparing amplitudes sign several ultrasonic frequency spectrum band.

Determination of tool wear trough monitoring the main spindle consumption is used moment due to its simplicity in implementation. From the principle point of view, the main spindle consumption monitoring it is similar to the torque monitoring because both methods provide information on the dynamics of cutting process [7].

Determination of tool wear trough monitoring contact resistance is an unconventional method for determination. The method vas developed by Ufa State Aviation Technical University.

In this method, a current of a known value (Is) is applied so to pass through the contact area of the tool and the workpiece. U voltage measurements are made after an appropriate interval needed for the values to stabilize [5].

The conductivity of the contact area can be expressed according to relation (1) [5].

$$G = \frac{1}{R} = \frac{I_S}{(U-E)} \qquad (1)\ [5].$$

Determination of tool wear using image acquisition systems is another method used.

The two main types of sensors are available visual CMOS sensors (complementary metal oxide semiconductor) and CCD (charge-couple device). CCD sensors are most commonly used because it creates better quality images with less noise.

4. THE INFLUENCE OF WARE ON THE QUALITY OF THE WORKPIECES.

Regardless of the method used to determine the wear, is important to establish the influence of wear on the surface quality of the workpiece.

The mechanical influence is dependent on several factors, namely the milling process parameters, tool materials and the type of materials being milled.

If the influence of wear on the work is analyzed, the optimal method is to directly determine the influence trough observations.

In figure 1 is presented a milling tool used to mill the workpiece presented in figure 2.

The milling was realized on a classical milling machine at parameters determined by analytical methods.

The linear speed of the milling tool was set at 200 mm/ minute, and the rotation of the tool was set at the 500 rpm.

Figure 1. Milling tool used for the experiment

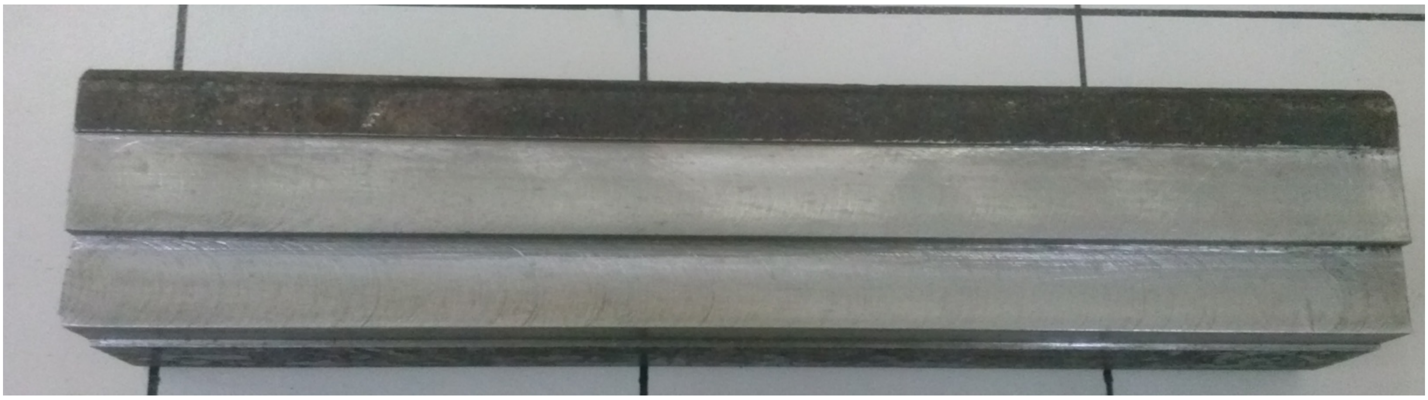

Figure 2. Workpiece milled using the tool in figure 1

Figure 3. Image acquisition stand (1 – Laptop, 2- optical microscope,

3- CCD Camera, 4- Work piece)

Using the experimental stand presented in figure 3, an image of the piece's surface was acquired in order to observe the evolution of the surface quality. The magnification used was 24 X and the vertical wall of the piece was analyzed.

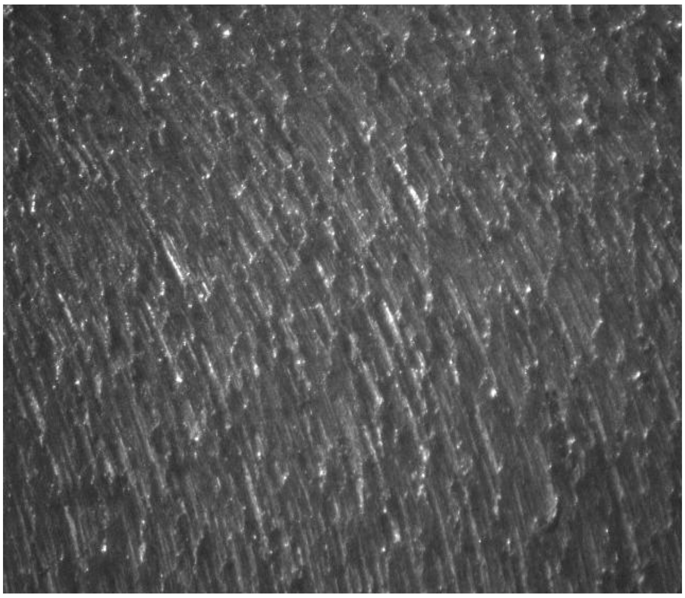

Figure 4. Image of the chipped surface with a new tool (magnification 25X)

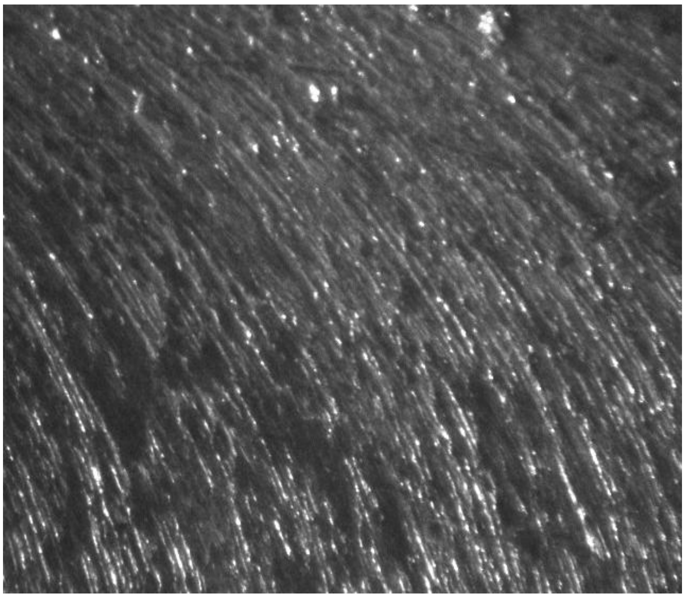

Figure 5. Image of the chipped surface with a tool that presents indicative of where (magnification 25X)

In figure 4 is presented the surface of the vertical surface of the piece (figure 2) that has been milled with the milling tool presented in figure 1, after the first milling (a 200 mm length milling process was realized). Basically, the surface is the surface that can be obtained with a new tool that has no wear.

The milling process was continued with the same tool and same material for a total of 60 minutes. No milling parameter was changed. The tool started to present some aspects of tool wear. After 60 minutes the image presented in figure 5 was acquired.

The difference in surface quality can easily be seen, and since no change was made to the parameters of the milling process were made, the difference in surface quality can be explained by modifications in the geometry of the cutting tool, modifications caused by tool wear.

5. Integration of the automatic tool readjustment function in flexible manufacturing cell and tool wear management strategies.

The tool wear is inevitable, but the effects of this process on the quality of machined surfaces can be controlled and reduced.

An automated system where realized that are able to adapt the milling parameters and avoiding the vibration problems that may affect processing according to data acquired during the milling process [6].

ATR function (Automatic Tool readjustment) is specific to CFF (flexible manufacturing cell) and SFF (flexible manufacturing system), automation levels.

ATR function mainly aims at increasing the efficiency of production respectively economic efficiency by reducing the auxiliary time required. In the first stage, ATR function has the objective of reducing tool change time when the production type changes in the manufacturing system.

When CFF /SFF start, the control system transfers to the ATR system tools necessary to manufacture the workpiece. The status check of the machine tool is realized that all tools required (specified in the list of tools taken from the control system) are present in the tool rack of the machine. If these conditions are satisfied (of course other parameters and conditions relating to the manufacturing are met), manufacturing of the piece is started. Simultaneously id informed the control system of the CFF / SFF which prepares and transfers the tool list for the next workpiece. Again the tool list is compared with the list of tools presented at the machine tool. If not, all tools are availability, the presence of the required tool are checked in the magazine associated with the ATR function. If these tools are available, ATR is activated during the processing previous workpiece and prepared a new set of tools. ATR is activated, the tool is exchanged, and the list of tools in the machine tools is updated and compared to the list of tools needed to process the next workpiece. If all tools are present after the activation of the ATR function, the processing of the workpiece is initialized.

If at CFF level implementation tool ATR may result in an increase in productivity by reducing the time required to prepare a new product by preparing a new set of tools during processing parts earlier, with the increase in the FMS level, the implementation of a centralized type ATR function (which assumes a central storage tool) has some significant advantages. By implementing the tool ATR and its correlation techniques for monitoring online tool wear or models for estimating tool wear reduce waiting for time in the system (mainly those failures or tool wear) by preparing at car tool which either have early signs of wear over the accepted limit or under mathematical model to determine wear, is no longer to produce poor quality parts.

These systems are derived from the time counting systems based on the use of tools but have a number of advantages. This system based on the monitoring of tool wear permits the use of the tool until the monitored parameter or parameters are exceeded. This can lead to using the tool for longer than the time set by the manufacturer (especially if they deviate high precision) or by altering levels monitored parameters may lead to increased precision machined parts (while reducing the time to use tools). These parameters are set so that the portion showing an optimum between the use of tools and product quality. Furthermore, the implementation tool ATR significant reduction of operating costs of the systems flexible (albeit in terms of initial costs of implementing the tool ATR involves extra effort) by reducing the waiting time to the machine tool and by reducing the need for a duplicate tool. This flexible system can duplicate the tool shed central tool in an amount less than would be required if each tool would have a double-wide machine, which is transferred by car to the monitoring tool wear indicates the possibility of exceeding the level of wear upheld. Tool wear that exceeded is transferred to the central repository of tools and then fix that by checking station (sharpening, replacement plates, etc.)

In this context, the implementation of ATR function in the modern manufacturing systems is related to not only the list of tools (conventional approach) but also a number of other parameters main tool wear.

6. CONCLUSIONS

The correlation between the tool wear and surface quality is easy to observe. By implementing an ATR function in a manufacturing system and having redundant tools, in combination with tool wear detection systems open the premises for new strategy's that can either increase or maintain a constant quality of the piece, or by changing the conditions or requirements to obtain the maximum number of pieces from each tool whiteout having a tool break and also operating a cost effective system even if in this case, the quality of the surface may not be constant.

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