Diagnosis of the use of automated systems for presetting of tools on CNC machine tools

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Abstract
To reach international levels of competitiveness, companies have focused on reducing losses in production processes. A loss that often goes unnoticed is on the presetting operation tools for CNC machines. This paper presents a diagnosis of the use of presetting tools in providers of machining service.
Keywords: Presetting, Machining service, Losses on production processes

INTRODUCTION

Losses on production processes are always a barrier to companies that aim to be recognized as world class manufacturing and to reach international levels of competitiveness.

Technological advances induce changes of the manufacturing systems that can reflect in all areas of industry, leading countries and companies to overcome barriers that limit their development (Correr et. al. 2006). The access to new technologies exposes companies to new

possibilities and new markets unexplored creating a scenario in which the increased demand for new products is stimulated by habits previously unknown (Groover, 2011). However, these new markets include clients that look for products with a high degree of customization.

The trend of producing goods individually and/or in small batches increased the importance of flexible equipment on the shop floor (Schwenke et al, 2008), leading machine tools to evolve and to make available more technological resources (Plotegher, 2012) in order to achieve more complex demands with higher quality (Lorincz, 2004).

To reach new production methods to became flexible, precise and with low costs, companies are searching for production methodologies to be also more productive (Jurko, 2011; Lott, 2011; Santos et al., 2006). In this same line of thinking, Raikiri and Parnichkun (2004) state that the most important factor to achieve quality of machined components is the precision (accuracy) of the machine tool and its additional features (accessories).

Nowadays CNC machines have sophisticated resources and can perform operations with more complexity (Plotegher, 2012). Among the technologies used as an auxiliary resource for machining on CNC machines, stand out the systems for the presetting of tools (presetters and toolsetters) in CNC machine tools. These systems aim to increase the flexibility of CNC machines, improving the quality and reducing the production cycle times of batches (Correr et al, 2011).

Smith (2008) e Correr et al. (2011) highlight to the application of toolsetting equipment on CNC machine tools with the following aims: optimize the production costs by reducing the setup time; improve the quality of presetting operations; and to monitor tools conditions during the machining processes. Vieira Junior et al (2014) also studied the influences of operational conditions of presetting operations over the results of machining processes, especially on the referencing operation of this equipment.

However, the effective use of this equipment is still incipient in Brazil. Some studies indicate to the low level of use of presetting resources by the CNC users (Santos et al, 2006; Correr et al, 2006; Simon, 2009; Simon, 2013). However, these studies did not focused to analyse the reason for this low use of presetters or toolsetters, and the following question arises: what are the reason for the low use of presetters/toolsetters by the users of CNC machines?

The most feasible hypothesis is that the cost of this equipment is the main barrier, but other reason can arise from a research: lack of knowledge about the benefits of the use of this equipment and lack of knowledge about the equipment and so more.

This article proposes to carry out a diagnosis about the reasons that lead to the low level of use of toolsetters and presetters among machining providers in Brazil. The methodology adopted was the survey.

PRESETTING SYSTEMS

Good presetting equipment can assure the return of the investment in CNC machine in less time than expected, once is one of the investments in the processes that can reduce the unproductive cycle of production. It can be adopted also for presetting operations, for the detection of tool breakage and to compensate deviations in the machine due to thermal effects (also called as "thermal drift").

Weatherall (1992) apud Simon et al. (2002) explains that the CNC has to "know" the dimensions of the tools, and these dimensions refer to a fixed adjusting point on the tool holder. The act of measure the tools and inform the command is the presetting operation.

The presetting of tools can be done also manually (internally or externally of the CNC machine) or automatically (also internally or externally of the CNC machine), according to Correr et al (2011). The manual internal presetting can only run when the machine is idle, while the manual external presetting can be performed with the machine in operation, measuring tools in metrology instruments, but after inserting the tools in the CNC machine, the measurements obtained must be confirmed.

These manual ways of adjusting the tools generates several unproductive times, adding costs to the process and, according to Simon et al (2002), can consume from 50 to 75% of the total time spent on the replacement of a tool.

Yet the automatic presetting uses the systems called **presetters**, which may be external or internal, the latter also known as **toolsetters** (Correr et al., 2006).

According to Correr et al (2011), the presetting of tools made with presetters or toolsetters produces substantial savings for companies, since the settings during the machining of the first part can be reduced or even eliminated, depending only on tolerance adopted in the process.

In general, CNC users consider that presetters are suitable in cases of large batches; however, Aronson (2000) says that also in batches of small volumes it can be suitable due to its greater accuracy and the elimination of losses of parts in the process.

METHODOLOGY

To answer the research question presented above, a survey was carried out among the providers of machining services that are users of CNC machines. The universe chosen were the companies located in the region of São Paulo city (also called as Great São Paulo). The respondents were the responsible for the sector of machining of the companies (machining managers or supervisors, most of them Engineers).

A questionnaire has been sent by e-mail to the companies with two blocks of questions:

- The first is about the use of presetting systems: number of CNC machines of the company; average number of tools used in the machining of each batch; average number of setups in each shift; average time spent with the presetting of tools; and the way the company performs its setup operations, with which kind of system and the number of systems that the company has.
- The second block is about the knowledge of the benefits of the use of presetting systems, including knowledge of the impact of presetting operations over the setup time; and the stated reason for not using the presetting systems.

After sending the questionnaires, a phone call was made for every company asking for the answer.

RESULTS AND DISCUSSION

From the 97 questionnaires sent by e-mail, 23 returned with the answers. Most of the companies (10 – equivalent to almost 43% of the respondents) stated to have up to 5 CNC machine tools, and 7 (almost 30%) declared to have from 6 to 10 machines. 4 of the companies (17%) declared to have more than 20 machines.

Regarding to the average number of tools used for the machining of each batch, 56% declared to use from 5 to 10 tools, 22 % stated that they use from 11 to 15 tools and the other 22% declared to use more than 15 tools in average per batch.

With reference to the average number of setups per shift, 82% of the respondents stated that they perform up to 5 setups per shift, 9% stated to perform from 6 to 10 setups and the other 9% perform more than 10 setups per shift.

A brief analysis of these answers indicates that even with a low number of setups per shift, there is the possibility that this operation demands a long time (number of tools x number of setups).

The scenario becomes more worrying when the time spent with presetting of tools is considered up to 5 minutes (65% of the respondents, while the other 35% state to spend more than 5 minutes – sometimes more than 10 minutes). It means that the time spent with presetting is high (considering 10 tools, with 5 setups per shift and demanding 5 minutes with each presetting ➔ 250 minutes spent with presetting operations in a shift that usually has 8 hours – 480 minutes, more than 50% of the total available time of the shift !!!).

The reason of this waste of time can be partially explained by the question: how does your company perform presetting operations? From the respondents, 52% stated that their presetting is performed manually, without any auxiliary resource. Only 13% stated to perform with toolsetters, automatically. In addition, 35% perform in the machine using information from an external presetting system, that requires manual insertion of data from tools and an initial machining of the piece to adjust the measures of the tools.

This situation is in conflict with the statement that the companies know the benefits of the use of presetting systems: 78% of the respondents stated to know all the benefits. However, when asked about the impacts of the presetting times over the setup times, 57% said that they did not know these impacts, and only 43% said that presetting has a high impact over setup times.

Although most of the companies have at least one equipment for the presetting of tools (74%), most of them also state that they do not use it due to the cost (53%), even though they already have one. It is also worth noting that 1 respondent highlighted the fragility of the equipment as a reason to not use presetting systems, and that 35% said that they do not use the system because their production is not serial, a mistake that lead this kind of answer to the class of “lack of knowledge about the presetting systems” (36% total).

CONCLUSIONS

The research conducted with the companies reported allows highlighting the following conclusions:

- Companies do not know the real impact of the presetting times over their setup times, which results in high waste of time and high production costs. More than 50% of the total time of a working shift can be spent with presetting of tools;
- Most of the companies that answered to the research stated that they perform the presetting manually or with information from an external presetting system that requires corrections of the measures inserted in the CNC after the first machining of the pieces from the batch. It confirms that they really do not know the impact of the presetting times over setup times;
- The main reason why the companies do not use presetting systems seems to be the cost of these equipments, but the lack of knowledge about these equipments benefits arises to be another feasible reason;
- Even though only one respondent stated that the fragility is the main reason to not use the presetting system, it is very concerning, because indicates that in the shop floor the CNC users prefer more robust equipment.

It is clear that a more relevant sample must be screened, including the expansion of the area surveyed. It will be done in a research that the authors are conducting with the financial support of FAPESP (Fundação de Amparo à Pesquisa do Estado de São Paulo, an institution from the State of São Paulo – Brazil government).

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