Journal of Achievements in Materials and Manufacturing Engineering
VOLUME 23
ISSUE 1
July
2007

Implementation of cutting tool management system

G. Svinjarević [a], A. Stoić [b,*], J. Kopač [c]
[a] Harburg-Freudenberger Belišce d.o.o.. Trg Ante Starcevica 1, Belišće, Croatia
[b] Faculty of Mechanical Engineering, University of Osijek,
Trg I. B. Mažuranić 2, 35000 Slavonski Brod, Croatia
[c] Faculty of Mechanical Engineering, University of Ljubljana,
Aškerčeva 6, 1000 Ljubljana, Slovenia
* Corresponding author: E-mail address: astoic@sfsb.hr

Received 23.03.2007; published in revised form 01.07.2007

Industrial management and organisation

ABSTRACT

Purpose: of this paper is to show the benefits of implementation of management of cutting tools in the company which specializes in metal cutting process, after which the production conditions alows new possibilities for improvement of the tool management.
Design/methodology/approach: applied in this paper was identification current state and exploatation conditions of cutting tools on lathes and milling machines and organization of the departments and other services, which are directly involved in the cutting tools management system.
Findings: of the controlled testings and analyses in every phase of tool management in departments and other services which are directly involved in the tool management system will help to reduce stock and costs. It is possible to identify which operator makes errors and is responsible for inappropriate use of cutting tool. Some disadvantages have been identified and a few suggestions for the improvement in the tool management system have been given. A result of research is easy to apply in company with developed informatic infrastructure and is mostly interesting for CNC workshops. Small companies and specialized low volume productions have to made additional effort to integrate in clusters.
Practical implications: are reduction of cutting tool on stock, reduction of employee, quick access to the necessary cutting tools and data, simplicity in tool order and supply. The most important is possibility to monitor and to identify which cutting tools and employees are weakest parts of chain in tool management system. Management activity should be foreseeable in all its segments, which includes both the appropriate choice and use of cutting tools, and monitoring of unwanted phenomena during the cutting process and usage of these data for further purchase of tools.
Originality/value: in the paper is turnover methodology applied for determination of management efficacy and formation of employees from different departments in virtual tool management system.
Keywords: Productivity and performance management; Cutting tool management; Costs and exploitation of tools

1. Introduction

Tool management in production, as a group of activities, aimed to ensure appropriate productivity, means on time availability of resources, undertaking limitations connected with the costs (time and material overcapacitation). Term tool management considers organization and implementation of a system which includes continuous activity monitoring, which are realized on two levels [1]:

- material (cutting tools) flow
- information flow (monitoring of the use of resources).

Cutting tool management, in the material sense, includes the appropriate choice and use of cutting tools, as well as continuous monitoring of unwanted phenomena on cutting tools during the period of cutting, e.g. breakages, intensive wear and overload of the cutting edge.

Appropriate cutting tool management, in the financial sense, beneficiary means decreasing of the costs over the period of time. Shortening of cutting time is possible to achieve with use of tools with better cutting performances. Decreasing of the production time can be also achieved by multi-purpose processing (parallel processing), with a quick change of tools, which are placed into the tool magazines of machines. If improper manufacturing resources (machine tools and procedures) are applied or if improper use of these resources arises, unfavorable future comes [2].

Very first step during tool management implementation is to establish a data base of cutting tools and to ensure a communication between the computers and personnel dealing with tools and located in several departments in company. Communication and access to certain tool data is based on code for every cutting tool which is actually a classification key.

There have been several models for the tool supply to a group of machines to overcome the short supply of tools. The optimal frequencies of distribution and the optimal ordering cycle as decision parameters is proposed for the tool supply to a group of machines based on the depot system [3].

Cutting tools, participates with about 2-4% in the structure of the production costs, so it can be concluded that the result of cutting tools savings by 30-50% contributes by only 1% in the total cost (Fig 1). Oppositely, if machining parameters increase with 20%, the cutting costs will decrease with 15 %.

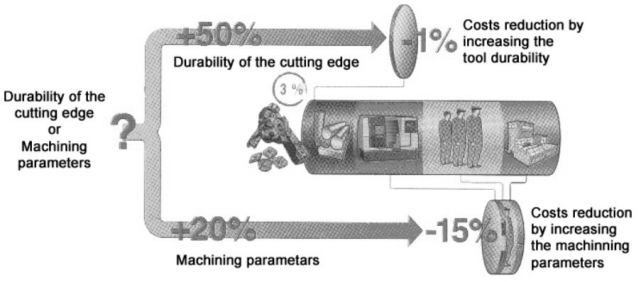

Fig. 1. Possible savings which are directly connected with cutting tools [4]

Increased machining parameters can in specific condition intensify non-uniform wear of the cutting edge, reported by Weinert [5] and Ravel at all [6] what decrease beneficiary costs. Adequate management of tools therefore induce new monitoring technique, presented with Barry at all [7].

2. Description of the assumptions and work methodology

Implementation of cutting tool management system has been analysed over two, the most important, phases of cutting tool flow through company: in time availability and best exploitation on machines. While analysing availability the greatest interests were focused on determination of minimal number of tools and employees in company dealing with tools and number of cutting tool suppliers.

The supply and selection of appropriate cutting tools has become as very complex task, regarding both the number of their producers and suppliers and a very complex classification and distinctive characteristics of tools. The costs for purchase of the tools represents a direct production cost (on average 2-4%), and can be far greater considering exploitation conditions of the tools. However, by rationalizing the exploitation conditions (operating regime) and by the appropriate choice of cutting materials a significant savings can be achieved, whereas production costs can be decreased [8].

In company chosen for analysis, four departments deal with supply of machines with cutting tools, i.e. less than 2,1% [9] of the employees (the number is a result of adding up shares of working time of the employees from 7 departments, which are shown below):

1. Supply department–1 employee (100% of the working time). His task is to supply cutting tools in needed quantity and quality
2. Export/import department -1 employee (20% of the working time). He undertakes specific actions regarding the import of cutting tools if the tools are being purchased from abroad.
3. Tool room – 1 employee (filing clerk) - concerned with ordering the tools, filing them, etc. and 2 employees – assembling and dissembling the tools, measuring, supplying of all the machines, etc. All the actions concerned with preparation and maintenance of the cutting tools are performed under instructions of the producers of the cutting tools.
4. Grinding shop – 2 employees
5. CNC programmers – 6 employees (5% of the working time is spent on making the tools lists and 5% of the working time is spent on choosing the appropriate tool)
6. Operators on conventional machines – 5 employees – 5% of the working time
7. Supervisors – 5 employees (10% of the working time in emergency situations, e.g. breakages of the cutting tools, consulting regarding the choice of appropriate cutting tools etc.)

In current conditions of increased exploitation of non-renewable resources, the duty of every producer is management of worn tools [10]. The most of cutting tools producers have developed a service for used carbide inserts, which is offered to the buyers (so called recycling concept). The buyers are offered a concept of reusing the carbide inserts by the producers (this recycling concept protects the environment). The inserts are transported in special containers to the nearest supplier or producer [10].

3. Description of results

3.1. Analysis of tools selection and supply

The company buys the cutting tools from 20 different suppliers (both foreign and domestic), of which are the shears of

the biggest 7 shown in Table 1.During the period of one year, there were 674 foreign orders of the cutting tools and cutting equipment and 1.064 orders from Croatia. The suppliers from Croatia delivered 21.566 tools, whereas the foreign ones delivered 14.281 tools.

The selection of cutting tools which will be used on CNC machines includes the choice of the inserts and it is usually chosen by CNC programmers, i.e. it is based on the tool lists made by the CNC programmers. Since there is no established system for choosing the best supplier/producer, inserts are usually delivered from familiar suppliers/producers, without further market research regarding the best characteristics of inserts from various other producers [11].

Table 1.
Relative amount of the cutting tools supply

Supplier	% , percentage in the total amount of the cutting tools supply
1	19,63
2	15,79
3	14,49
4	9,04
5	6,91
6	6,30
7	5,92
Others	21,92
Total	100,00

Cutting tools suppliers conduct periodical control examinations of cutting possibilities of newly developed inserts which replace the existing ones. The cutting insert of a certain supplier with better performance will replace the insert of poorer performance, so that it has higher priority in the supplying system.

The needed amount of cutting inserts can be relatively quickly obtained from the tool list, so that a programmer can define from the duration of the operating process and for the familiar expectancy span of the inserts the needed quantity of a certain tool on the tool list. By comparing this piece of information with the number of cutting inserts per every machine, the appropriate exploitation of a cutting insert can be tested.

The situation regarding the choice of suppliers for cutting inserts is similar with conventional machines, but there are differences when ordering the needed amounts, and so the stock of the inserts in the tool room, since is defined by the tool specialist (i.e. the worker who works in the tool shop).

By monitoring the inventory turnover in the tool shop, the efficiency of the tool experts can be observed with equation:

$$T_{ct} = P_{ct} / St_{ct} \quad (1)$$

T_{ct} - Turnover of the cutting tools
P_{ct} - purchased quantity of the cutting tools per year;
ST_{ct} - the current value of the cutting tools in stock.

The efficiency of the tool specialist is better if the value of T_{ct} is higher, i.e. if he/she has a small amount of cutting tools in stock. If the production varies, then the quantity of the cutting tools, which are purchased per year, can be analysed using the following formula:

$$It_{ct}=Tc_{ct2006} / Tc_{2006} \quad (2)$$

It_{ct} – index; percent of the tools costs in year/total costs in year
Tc_{ct2006} – total costs of the cutting tools (year 2006)
Tc_{2005} – total costs (year 2006)

The analysis conducted in the company for the period from 1 January to 31 December shows that the cost of cutting tools on a yearly basis is 4,36% (It_{ct} = 4, 36%) in relation to the value of the total cost.

3.2. Analysis of cutting tools exploitations

Conditions of the cutting tools exploitation are specific for each company, and show primarily the state and possibilities of the machines. The cutting tools producers define recommended exploitation conditions for every cutting tool, which will provide the optimum life expectancy of the tools, and hence the costs related to the tools by recycling the partially used tools within the manufacturing cell [12].

The analysis of the cutting tools exploitation conditions has been conducted on CNC machines (signed as A, B, C, D) for turning and (signed as E, F) milling (Figs 2 and 3). Both rough and final processing have been analysed on the most frequent materials in production. Raw material was S235JR while inserts used for testing on machines A-D were:

A. CNMG 12 04 08 – PM; quality: 4025
B. DNMG 15 06 04 L-K ; quality : 2035
C. CNMG 19 06 08 MR ; quality : 235
D. WCMX 08 04 12 R-53 ; quality : 1020
E. HSS milling sutter 18 mm diameter
F. RPNX 12 04 MOSN – 29 ; ISO HC P25 (Ceratizit).

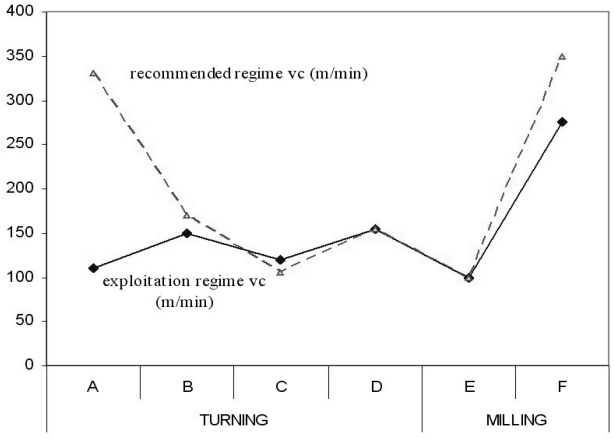

Fig. 2. The relation between the actual and recommended cutting speed by turning and milling [9]

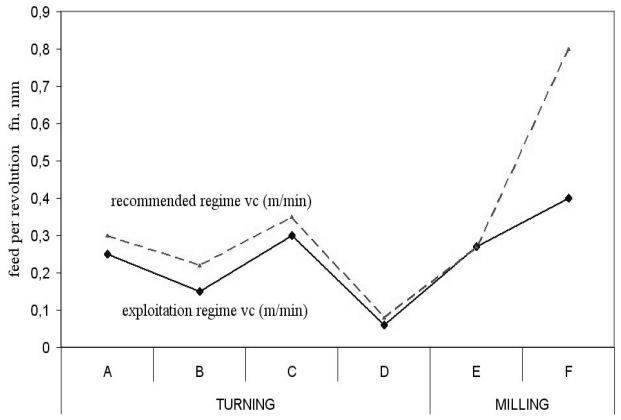

Fig. 3. The relation between the actual and recommended feed during turning and milling [9]

Deviation from actual and recommended values can be explained on every sample where the deviations are significant. From Figs 2 and 3 it can be concluded that the cutting tools are exploited in conditions with efficiency of 80%. To avoid this loss and to improve efficiency of machining, specialised programmes [16] were developed to select optimal cutting conditions from commercial databases with respect to the lowest costs of machining by taking into account the technological limitations of the metal removal process.

4. Conclusions

The results obtained after the analysis of cutting tools costs justified need for implementing a systematic approach for tool management, as well as for certain activities with the emphasis on rationalization.

The activities connected with tool management are in some departments difficult to achieve without an established database and a computer backup. In departments with no computer support or some other simplified management system a certain number of disadvantages have been detected, which in a direct or indirect way result in the increase of the total production cost due to an inadequate use of the cutting tools. The activities connected with borrowing the tools from the Tool shop should be primarily emphasized, as well as the returning of the same after the end of machining process back to the Tool shop. Since there is not any software for borrowing the tools in the Tool shop, there is no responsibility which results from it.

Besides, it should be pointed out that the activities of renewing the cutting properties with grinding , which may increase the tools' durability even more than 20%, and in that way the total costs for the cutting tools may be reduced.

The exploitation conditions of the cutting tools are also important for the process of tool management, but they are also indicators of good working order of the machines. It is a well known fact that savings from decreased machining regimes on account of cutting tolls machines' inability are insignificant (-1%) in relation to the savings achieved on modern machines with recommended machining regimes (-15%). Improvements are being implemented by continuous modernization of the cutting tools machines.

The data obtained from the analysis of the exploitation conditions of the cutting tools in this company (cutting tools are represented with 4,36% in the total purchase of resources, which is a direct cost, more that 2% of the employees' are connected with tool management, and as a result of inadequate use of their cutting possibilities, the production costs rise by 12%, which is an indirect cost) suggest that there is still space for improvements that can be used by the company in its process of rationalization.

References

[1] R. Cebalo, International scientific book on manufacturing, Zagreb, ISBN 953-96501-8-6, 2005.
[2] A. Stoić, J. Kopač, G. Cukor, Testing of machinability of mould steel 40CrMnMo7 using genetic algorithm, Journal of Materials Processing Technology 164-165 (2005) 1624-1630.
[3] G. Vrecer, F. Cus, Planning of tool supply to a group of machines, Journal of Materials Processing Technology 133 (2003) 214-217.
[4] Sandvik Coromant, Corokey, catalogue of tools – Sandvik Coromant, Sandviken, 2000.
[5] K. Weinert, L. Cronjäger, Relation between process energy and tool wear when turning hardfacing alloys, Annals of the CIRP 43/1 (1994) 97-100.
[6] R. Pavel, I. Marinescu, M. Deis, J. Pillar, Effect of tool wear on surface finish for a case of continuous and interrupted hard turning, Journal of Materials Processing Technology 170 (2005) 341–349.
[7] J. Barry, G. Byrne, Cutting tool wear in the machining of hardened steels, Part I: alumina/TiC cutting tool wear, Wear 247 (2001) 139-151.
[8] J. Kopač, M. Soković, Cutting technique, Univerza v Ljubljani Fakulteta za strojništvo, Ljubljana, ISBN 86-7217-097-0, 1993, (in Slovenian).
[9] G. Svinjarević, Cutting tool management in company thyssenkrupp Belišće doo, University in Osijek, Strojarski fakultet u Slavonskom Brodu, diploma work, 2005, (in Croatian).
[10] Sandviken Coromant, Extended Service Agreement, Sandviken, 2004.
[11] J. Kopač, A. Stoić, M. Lucić, Dynamic instability of the hard turning process, Journal of Achievements in Materials and Manufacturing Engineering 17 (2006) 373-376.
[12] M. Özbayrak, A.K. Turker, R. Bell, Recycling of cutting tools in flexible manufacturing systems, International Journal of Computer Integrated Manufacturing 16 (2003) 409-427.
[13] G. Vrecer, F, Cus, Planning of tool supply to a group of machines, Journal of Materials Processing Technology 133 (2003) 214-217.
[14] B. Mursec, F. Cus, J. Balic, Organization of tool supply and determination of cutting conditions, Journal of Materials Processing Technology 118 (2001) 485-489.
[15] F. Pusavec, P. Krajnik, J. Kopac, High speed cutting of soft materials, Strojniski vestnik 11 (2006) 706-722.
[16] F. Cus, B. Mursec, Databases for technological information systems, Journal of Materials Processing Technology 157-158 (2004) 75-81.