西南交通大学学报

第 57 卷 第 3 期
2022 年 6 月

JOURNAL OF SOUTHWEST JIAOTONG UNIVERSITY

Vol. 57 No. 3
June 2022

ISSN: 0258-2724

DOI：10.35741/issn.0258-2724.57.3.27

Research article

Engineering

Machining by Chip Removal: Bibliometric Analysis, Evolution, and Research Trends

通過去除芯片進行加工：文獻計量分析、演變和研究趨勢

Diana Carolina Gálvez Coy *, Pablo Andres Erazo Muñoz, Fernando Londoño Zapata, John Alexander Ortiz Torres, Carloman Arcila Zuluaga

Research Group Electronics, Automation and Renewable Energies EAYER, Centro de Automatización Industrial, SENA Regional Caldas

Manizales, Caldas, Colombia, dgalvezc@sena.edu.co

Received: May 7, 2022 ▪ Reviewed: June 6, 2022
▪ Accepted: June 18, 2022 ▪ Published: June 30, 2022

Abstract

This paper aims to acquaint the readers with the research trends in the area of machining by chip removal, which has been widely used as a process of component manufacturing in industry, through bibliometric analysis. In this paper, the review and the network analysis were obtained by tools such as Bibliometrix in R, VOSviewer, Sci2, and Gephi to identify the tree of science of the literature related to machining by chip removal. This review identified four main lines or clusters related to modeling of machining processes, machining processes, machining fluids, and machining surface monitoring. This allows teachers, researchers, and academicians interested in the topic to know its evolution and trends to guide subsequent research.

Keywords: Bibliometric Analysis, Machining, Manufacturing, Sci2

摘要 本文旨在通過文獻計量分析，讓讀者了解已廣泛用作工業部件製造工藝的排屑加工領域的研究趨勢。本文通過 R 中的参考书目、视频操作系统查看器、科学 2 和格菲等工具進行綜述和網絡分析，以確定與排屑加工相關的文獻科學樹。在本次審查中，確定了與加工過程建模、加工過程、加工液和加工表面監測相關的四個主線或集群。這可以讓對該主題感興趣的教師、研究人員和院士了解其演變和趨勢，從而為後續研究提供指導。

关键词: 文獻計量分析，加工，製造業，科學 2

I. INTRODUCTION

The machining by chip removal and metal removal processes, as well as cutting tools, have had a relatively slow but steady technological advance throughout the history of humanity [1]. However, as the manufacturing processes of materials, including steel through the enhancement of crucibles, were improved, it was possible to design more complex and consistent components, which required the development and refinement of machine tools capable of producing them. Therefore, thanks to the establishment of companies committed to making these machines better, it was possible to have the first important advance to improve the technique by the middle of the 18th century, which coincided with the beginning of the first industrial revolution [2].

A second advance in the machining by chip removal technique took place throughout World War II and the subsequent years when the need to produce high-quality machine parts on a global scale required for the war and the posterior reconstruction and strengthening of the countries immersed in the conflict enabled novel machines development [3]. Consequently, the CNC (computer numerical control) system was created, and new questions and challenges, such as those related to cutting fluids and energy use, were posed [4], [5]. Such concepts are current research objects considering their great profitability and quality, evident in machining by chip removal [6]. Thus, the first bibliometric study on this process is carried out because of its importance for the efficiency and productivity of the companies that use it in their production processes.

Although, in the last two decades, researchers have studied machining, only a few studies have tried to organize the academic literature to explain the development in machining research by chip removal. Therefore, this study constitutes a relevant starting point that can be useful to both academics and practitioners to identify opportunities for future research. Therefore, this research aims to identify the evolution and trends of the scientific literature in the field of machining by chip removal through the methodology recently implemented by Muñoz and Casallas [7], Muñoz et al. [8], Arenas et al. [9] and Ramos-Enríquez et al. [10]. Such methodology uses graph theory and author networks for document analysis, supported by bibliometric analysis tools such as Sci2, Gephi, VOSviewer, and Bibliometrix, which have demonstrated rigor and reliability in their results.

II. METHODOLOGY

A bibliometric and network analysis was carried out to identify the evolution and trends of the scientific literature on machining by chip removal, using the methodology proposed by Muñoz et al. [8]. It was validated and applied in similar exercises by Arenas et al. [9], who carried out a bibliometric analysis of the evolution and trends of scientific production in industrial production management. The method proposed by Muñoz et al. [8] was an adaptation of the article “Bibliometric Methods” published in the journal Organizational Research Methods by Zupic and Čater [11], which has also been adapted and used to find the trends and challenges of industrial and operational engineering by Tseng et al. [12], knowledge and future lines in radical innovations [13], analysis and bibliometric review on blockchain and energy [14], review agenda and research in open innovation in the manufacturing industry [15] and other fields such as happiness at work and work performance [7]. All the previous works were published in high-impact journals, which makes it possible to establish that the method used for this review is valid for this type of exercise. The application of the method in its main stages is described below:

A. Creation of the Sci2 Network

With the references obtained from the search in WoS and Scopus using the keyword equation ("machining process" OR "metal cutting"), the database was created with the following information for each article: author, title, year, DOI, source, and references. This information was processed with the Sci2 software (2009) to identify the relationships between the articles in the database and those cited. Thus, all kinds of information sources such as articles, books, reports, working papers, web pages, catalogs, and others were included.

The network created in Sci2 was exported to Gephi, open-source software for graph and network analysis.

B. Creation of the Tree of Science

The tree of science was made according to the methodology proposed by Robledo et al. (2013) and using the bibliometric review of the study object. It allowed us to identify the relevance of the articles, which were classified into three categories: the first one, the root, shows the articles with a high degree of entry and zero exits; the second one, the trunk, shows the articles with a high degree of intermediation; the third one, the leaves, also called the perspectives, shows the articles with a high degree of exit and zero-entry [7].

C. Creation of Clusters

The identical algorithm establishes relationships between the keywords and the sources to detect the trends and patterns that recognize similar areas. For example, the machining by chip removal process as well as metals and cutting tools have had a relatively slow but steady technological advance throughout the history of humanity [1]. As the manufacturing processes of materials, including steel through the enhancement of crucibles, were improved, designing more complex and consistent components as possible.

III. Results and Discussion

The review in Scopus and WoS of the equation: ("machining process" OR "metal cutting") in title keywords and abstract indicated that between the years 2000 and 2020, 6,149 documents had been published in WoS and 19,834 in Scopus. Figure 1 shows that the publications on this topic are in constant but slow growth. For example, none of the years exceeded 10% of the total publications in Scopus and 12% in WoS.

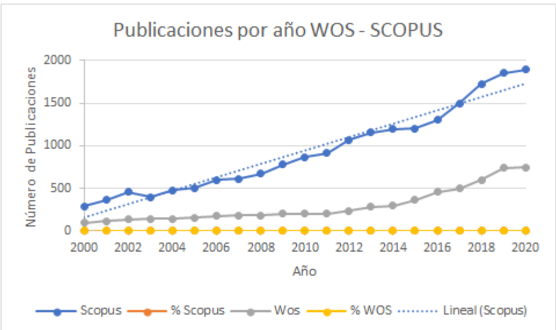

Figure 1. Publications in machining by chip removal

Zhanqiang Liu, a researcher at the School of Mechanical Engineering of the University of Shandong (China), the Key Laboratory of high efficiency and clean mechanical manufacturing of MOE, and a researcher at the National Demonstration Center for Experimental Mechanics Education, is the most prolific author on this subject with 35 publications in WoS and 55 in Scopus. On the other hand, Berend Denkena is the most prolific author on the studied subject in Scopus with 88 publications, including his most recent publication regarding the identification of multiple conditions in thin-walled workpieces milling [16]. Another finding was that the majority of the most representative authors of WoS come from China and those of Scopus from Germany.

The People's Republic of China, followed by India, has been making more publications on machining and metal cutting processes in recent years. The United States has many publications, but these are less recent than those of China and India. Also, Iran has been making recent publications on the subject.

A. Tree of Science of Publications in Machining and Metal Cutting Processes

Figure 2 shows the tree of science of the most representative classic, structural and current articles in machining and metal cutting processes made with Sci2 and Gephi.

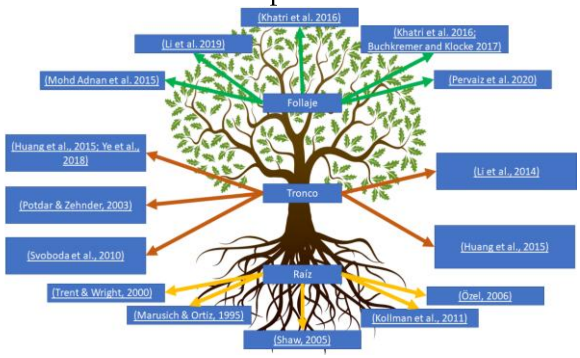

Figure 2. Tree of science in machining and metal cutting processes

Tables 1, 2, and 3 show each document's detailed information and a brief description.

Table 1.
Classic documents (root)

Document	Journal/Source
Metal cutting principles, Second Edition [1]	Oxford University Press on Demand
Modeling and simulation of high-speed machining [17]	International Journal for Numerical Methods in Engineering
The influence of friction models on finite element simulations of machining [18]	International Journal of Machine Tools & Manufacturing
Metal Cutting [1], [19]	Metal Cutting
Metal Machining Theory and Applications [19]	Metal Machining Theory and Applications (Book)
Manufacturing Automation: Metal Cutting Mechanics, Machine Tool Vibrations, and CNC Design [3]	Cambridge University Press

The article "Metal cutting principles" by Trent and Wright are among the classic documents of the machining by chip removal area [2]. It presents the historical description of metal cutting and how the evolution of the technique has been linked to events as important as the industrial revolution and the world wars. This article also praises the knowledge transmitted informally through former artisans and forgers who achieved advances in cutting tools and improved efficiency of the processes that could be developed by then.

Such knowledge has been compiled in academic publications such as guide books that show the necessary techniques and methodologies as a knowledge base for subsequent research. Books such as "Manufacturing Automation: Metal Cutting Mechanics, Machine Tool Vibrations, and CNC Design" [3] and "Metal Machining Theory and Applications" [19] have been used to teach topics such as generalities, nomenclature, deformations, and other contents considered basic for any scholar or person interested in the metal cutting topic.

Other books, such as "Metal cutting principles, Second Edition, by the author [1], describe in detail modern techniques such as high-speed orthogonal machining and the most important metal cutting operations with their most important characteristics, namely, elastic behavior, plastic behavior, fracture, dynamometry, steady-state shear stress, pure shear tension, friction, wear and duration of the tool, cutting temperatures, cutting fluids, tool materials, considerations on the working material, complex tools, surface integrity, modeling and optimization of chip formation, precision engineering, unusual applications of machining among others.

The article "Modelling and simulation of high-speed machining" by the authors [20] delves deeper into machining and explains developing a Lagrangian finite element model of high-speed orthogonal machining. It also shows continuous and adaptive meshing as the main tool to avoid element distortion problems caused by deformation and a chip formation model with a continuous chip to segmented chip transition with increasing cutting velocity. This topic is subsequently discussed in the article "The influence of friction models on finite element simulations of machining" [18] together with the flow of the working material, as fundamental study factors for any finite elements simulation process related to machining by chip removal.

Table 2.
Structural documents (trunk)

Document	Journal/Source
Optimization of cutting parameters for energy saving [21]	International Journal of Advanced Manufacturing Technology
A flexible and effective NC machining process reuse approach for similar subparts [22]	Computer-Aided Design and Applications
Design and development of a CNC machining process knowledge base using cloud technology [23], [24]	International Journal of Advanced Manufacturing Technology
Measurements and Simulations of Temperature and Deformation Fields in Transient Metal Cutting [25]	Journal of Manufacturing Science and Engineering
Simulation of metal cutting using a physically-based plasticity model [26]	Modeling and Simulation in Materials Science and Engineering

Machining techniques have had little variation since their inception. However, some machining conditions from cutting advances to the deformation temperature of the material have changed meaningfully, as described by Svoboda et al. [26] in the article "Simulation of metal cutting using a physically-based plasticity model," which mentions some types of deformations that can be modeled by software according to the mechanical properties of the materials. Likewise and thanks to advances in computing and simulation by finite elements, it has been possible to conduct studies such as “Measurements and Simulations of Temperature and Deformation Fields in Transient Metal Cutting” [27], which developed several tests on materials. It showed, through the use of infrared sensors, how the data obtained resembled those obtained in the iterative simulations where the parameters were adjusted to obtain the expected results.

Machining is a process that shapes many products in the manufacturing industry, but it has been and continues to be an energy-inefficient process that reports up to 37% of global energy consumption in the manufacturing industry alone. Consequently, as mentioned by J.-G. Li et al., [28] in the document "Optimization of cutting parameters for energy-saving," it is necessary to choose adequate cutting parameters to improve the energy efficiency of the machining process and achieve greater production and less tool wear.

Thanks to this type of study, the fact that today computerized numerical control machines outperform conventional machines in efficiency and effectiveness thanks to their great automation capacity and high performance is evident. However, due to the lack of knowledge in the machining process planning, manufacturing processes depend mainly on the skills of the programmers and the operators and not on the machine's capacity. This is why Ye et al. [29] propose a machining knowledge database for the user to obtain data and parameters by entering the initial data of the problem or the required process through programming tools such as MapReduce, knowledge query engines, and reasoning engines, which reduce the machining processes programming times. In addition, databases linked to search software that reused components with mechanical and geometric characteristics similar to those needed by the user to reduce machining times and, therefore, final products have been created [22].

Table 3.
Recent documents (leaves)

Document	Journal/Source
Fuzzy logic for modeling machining process: a review [30]	Artificial Intelligence Review
A cloud-terminal-based cyber-physical system architecture for energy-efficient machining process optimization [31]	Journal of Ambient Intelligence and Humanized Computing
Ultrasonic vibration-assisted electric discharge machining: A research review [31], [32]	Journal of Engineering Manufacture
Compilation of a thermodynamics-based process signature for the formation of residual surface stresses in metal cutting [33]	Wear An International Journal on the Science and Technology of Friction Lubrication and Wear,
Role of energy consumption, cutting tool and workpiece materials towards environmentally conscious machining: A comprehensive review [6]	Journal of Engineering Manufacture

Currently, there are several studies in the scientific field of machining. Computational analyses of the process effects on the tool, new hard materials cutting techniques, and improvements through simulations of the process's overall efficiency show how the technique remains in force. Some articles are described below, briefly showing the current direction of metal machining by chip removal.

The authors Buchkremer and Klocke [36] used the finite element method (FEM) in their article "Compilation of a thermodynamics based process signature for the formation of residual surface stresses in metal cutting." They showed how thermal, mechanical, and dissipative energies play a crucial role in forming residual stresses present in cutting tools after using them in hard metals with heat treatments such as AISI 4140. Therefore, the focus was not only on the part to be manufactured but also on the cutting tool, a fundamental part of the process on which profitability is enormously placed.

The article "Ultrasonic vibration-assisted electric discharge machining: A research review" [32] compiles information about the effect of ultrasonic vibrations on electric discharge machining and shows how their complementary use noticeably improves the machining of extremely hard metals.

The authors also claim that future research on the subject will improve the energy efficiency of this type of machining but will also make the process more profitable and desired by the manufacturing sector.

As mentioned above, the current studies seek to increase the economic profit of the machining and cutting metal processes through the improvement of the energy efficiency of the technique. However, articles such as “Role of energy consumption, cutting tool and workpiece materials towards environmentally conscious machining: A comprehensive review" [6] explain another increasingly important approach without deviating from the economic field.

It describes the efficiency of the process at the energy level and the need for improvements to include cutting-edge technologies that solve environmental problems such as the disposal of cutting fluids and waste to transform the process into a completely sustainable one.

Finally, the article "A cloud-terminal-based cyber-physical system architecture for energy-efficient machining process optimization" deals with the current use of cutting-edge computer tools in the manufacturing industry as well as machining process management and optimization by real-time monitoring of the machine's operations based on cloud interconnection in order to advance immediate corrective actions [31].

Furthermore, the article "Fuzzy logic for modeling machining process: a review" by Mohd Adnan et al. [30] describes the use of artificial intelligence routed to strengthen the control of the machining process to obtain superior quality results.

B. Clusters in the Scientific Production of Machining and Metal Cutting

One of the contributions of this bibliometric and network analysis to machining and metal cutting is the identification of clusters that recognize common trends or current issues. The clusters that were identified are:

Cluster 1 – Modelling of Machining Processes

Fourteen-point, seven percent of the publications on machining and metal cutting correspond to the subject of the machining process model related to the effects of aspects such as heat, friction, physical impacts, type of cutting tool material, and type of material being cut, and cutting angles of the tool, among others, on the cutting process. Researchers have used different techniques to reduce these effects. According to the literature, the Finite Element Method (FEM) is the most used. Sadeghifar et al. [34] provide an example of such a technique in the article "A comprehensive review of finite element modeling of orthogonal machining process: chip formation and surface integrity predictions," which explains the use of the FEM to study the behavior of the cutting tools used in the turning process. The analysis includes factors such as temperatures generated by friction and the effort caused by the forces that intervene in the cutting process. Likewise, the article "Simulation of metal cutting using a physically-based plasticity model" by Svoboda et al. [26] shows a model based on experimental data adapted to the FEM.

Cluster 2 - Control of Machining Processes

Ten-point seven percent of the publications on machining and metal cutting correspond to applying artificial intelligence (AI) techniques to modeling machining processes. Regarding this subject, Mohd Adnan et al. [30] are some of the most prominent authors with their article "Fuzzy logic for modeling machining process: a review" that shows fuzzy logic (FL) as a well-known AI technique effectively used in the modeling of machining processes. It also explains FL as an approach to estimating surface roughness and controlling the cutting force in various machining processes. The authors conclude that FL is the most popular AI technique used in modeling machining processes and, thus, promotes a potential approach for machining process optimization. Other advances in computer science are also frequently used in industrial areas that were believed to be immovable a few years ago. This is how, through genetic algorithms, the optimization of production processes, including machining by chip removal, becomes economically more profitable. It happens thanks to the simplicity of determining factors such as roughness, shear force, and others through this type of programming, as shown by the authors Chakraborty et al. [35] and Reséndiz-Flores [36].

Cluster 3 - Machining Fluids

Ten-point twenty-five percent of the publications on machining and metal cutting correspond to the topic of machining fluids, which are vital in the machining process due to their influence on the preservation of the machine and tools, energy efficiency, and finishing of the piece [37]. However, although the need to use machining fluids is clear, it is also clear that as an input and surplus product of any process involving the transformation of raw material into consumer goods, its use harms the environment and human health [38]. Therefore, in addition to studying how the use of such fluids provides the best working conditions to a wide sector of the manufacturing industry, the approaches and strategies that allow their optimal use and the use of slightly more sustainable and environmentally acceptable cooling and lubrication methods that can replace them are also studied [39].

Cluster 4 – Machining Surface Monitoring

Eight-point forty-nine percent of the publications on machining and metal cutting correspond to the design of current machines used for machining by chip removal; this cluster includes multifunctional tools mounted on automatically interchangeable heads [40]. Authors such as Lu et al. have considered such characteristics and others [41] in their article "Machined Surface Quality Monitoring Using a Wireless Sensory Tool Holder in the Machining Process," which proposes a permanent monitoring system with wireless sensors in different heads and tools of the machines in order to generate models that allow predicting the final roughness of the pieces. Furthermore, thanks to other studies, such as those also carried out by Lu et al. [42] in their article "In-process complex machining condition monitoring based on deep forest and process information fusion" that uses data mining, it is possible to constantly monitor not only a single variable, but also various types of abnormalities, which allows making in situ decisions on the completion of machining or its reprogramming.

IV. Conclusion

This article presents a bibliometric analysis of machining by chip removal alloy research publications from 1st January 2000 to 31st December 2020 from the WoS database, presenting the research status, evolution process, and main research themes,

Therefore, the results in this study enable us to conclude that this topic is relevant to the industrial evolution of some countries, such as China, where manufacturing studies have been multiplying; other countries whose economies are starting to become globally relevant, such as India are not lagging; showing updated in contributions to machining technology.

Four clusters were obtained based on the cluster analysis, including modeling of machining processes, control of machining processes, machining fluids, and machining surface monitoring. The four clusters reflect the current hot themes associated with machining by chip, which has remained at the center of mechanical technology, reinventing itself and maintaining its relevance.

REFERENCES

[1] SHAW, M.C. (2005) *Metal Cutting Principles. Oxford University Press on Demand*. [Online]. Available: https://books.google.com/books/about/Metal_Cutting_Principles.html?hl=&id=VxNiQgAACAAJ

[2] TRENT, E.M., and WRIGHT, P.K. (2000) Metal cutting operations and terminology. *Metal Cutting*, pp. 9–20.

[3] ALTINTAS, Y., and VER, A.A. (2001) Manufacturing Automation: Metal Cutting Mechanics, Machine Tool Vibrations, and CNC Design. *Applied Mechanics Reviews*, 54(5), pp. B84–B84.

[4] DORNFELD, D.A. (2012) Green Manufacturing: Fundamentals and Applications. *Springer Science & Business Media*. [Online]. Available: https://play.google.com/store/books/details?id=XRqHvaKTXZYC

[5] GUPTA, K. (2019) *Innovations in Manufacturing for Sustainability*. Springer, 2019. [Online]. Available: https://books.google.com/books/about/Innovations_in_Manufacturing_for_Sustain.html?hl=&id=9SZLvAEACAAJ

[6] PERVAIZ, S., KANNAN, S., DEIAB, I., and KISHAWY, H. (2020) Role of energy consumption, cutting tool and workpiece materials towards environmentally conscious machining: A comprehensive review. *Proc. Inst. Mech. Eng. Pt. B: J. Eng. Manuf.*, 234(3), pp. 335–354.

[7] MUÑOZ, P.A.E., and CASALLAS, M.I.R. (2021) Relación entre felicidad en el trabajo y desempeño laboral: análisis bibliométrico, evolución y tendencias//Relationship between happiness at work and job performance: a bibliometric analysis, evolution and trends. *Revista Virtual Universidad Católica del Norte*, 64, pp. 241–280.

[8] MUÑOZ, P.A.E., GÓMEZ, C.A.R., COLONIA, A.G., and SÁNCHEZ, N.E. (2019) La vigilancia científica como apoyo a la gestión educativa. *Rutas Formación: Pract. Experiencias*, 9, pp. 21–35.

[9] ARENAS, C.Z. (2020) La vigilancia científica como apoyo a la gestión educativa. *Rutas Formación: Pract. Experiencias*, 10, pp. 60–75.

[10] RAMOS-ENRÍQUEZ, V., DUQUE, P., and SALAZAR, J.A.V. (2021) Responsabilidad Social Corporativa y Emprendimiento: evolución y tendencias de investigación. *Desarrollogerencial*, 13(1), pp. 1–34.

[11] ZUPIC, I., and ČATER, T. (2015) Bibliometric methods in management and organization. *Organ. Res. Methods*, 18(3), pp. 429–472.

[12] TSENG, M.-L., TRAN, T.P.T., HA, H.M., BUI, T.-D., and LIM, M.K. (2021) Sustainable industrial and operation engineering trends and challenges Toward Industry 4.0: a data-driven analysis. *J. Inst. Eng. India Part PR Prod. Eng. Div.*, pp. 1–18.

[13] TIBERIUS, V., SCHWARZER, H., and ROIG-DOBÓN, S. (2021) Radical innovations: Established knowledge and future research opportunities. *J. innov. knowl.*, 6(3), pp. 145–153.

[14] ANTE, L., STEINMETZ, F., and FIEDLER, I. (2021) Blockchain and energy: A bibliometric analysis and review. *Renewable Sustainable Energy Rev.*, 137(110597), p. 110597.

[15] OBRADOVIĆ, T., VLAČIĆ, B., and DABIĆ, M. (2021) Open innovation in the manufacturing industry: A review and research agenda. *Technovation*, 102(102221), pp. 102221.

[16] WANG, R., SONG, Q., LIU, Z., MA, H., and LIU, Z. (2022) Multi-condition identification in milling Ti-6Al-4V thin-walled parts based on sensor fusion. *Mech. Syst. Signal Process.*, 164(108264), pp. 108264.

[17] MARUSICH, T.D., and ORTIZ, M. (1995) Modelling and simulation of high-speed machining. *Int. J. Numer. Meth. Engng.*, 38(21), pp. 3675–3694.

[18] ÖZEL, T. (2006) The influence of friction models on finite element simulations of machining. *International Journal of*

Machine Tools and Manufacture, 46(5), pp. 518–530.

[19] MAEKAWA, K., OBIKAWA, T., YAMANE, Y., and CHILDS, T.H.C. (2013) *Metal Machining: Theory and Applications*. Butterworth-Heinemann, 2013. [Online]. Available: https://play.google.com/store/books/details?id=p2LJOOfhaIIC

[20] MARUSICH, T.D., and ORTIZ, M. (1995) Modelling and simulation of high-speed machining. *Int. J. Numer. Meth. Engng.*, 38(21), pp. 3675–3694.

[21] LI, J.-G., LU, Y., ZHAO, H., LI, P., and YAO, Y.-X. (2014) Optimization of cutting parameters for energy saving. *Int. J. Adv. Manuf. Technol.*, 70(1–4), pp. 117–124.

[22] HUANG, R., ZHANG, S., XU, C., ZHANG, X., and ZHANG, C. (2015) A flexible and effective NC machining process reuse approach for similar subparts. *Comput. Aided Des. Appl.*, (62), pp. 64–77.

[23] HUANG, R., ZHANG, S., XU, C., ZHANG, X., and ZHANG, C. (2015) A flexible and effective NC machining process reuse approach for similar subparts. *Comput. Aided Des. Appl.*, 62, pp. 64–77.

[24] YE, Y., HU, T., ZHANG, C., and LUO, W. (2018) Design and development of a CNC machining process knowledge base using cloud technology. *Int. J. Adv. Manuf. Technol.*, 94(9–12), pp. 3413–3425.

[25] POTDAR, Y.K., and ZEHNDER, A.T. (2003) Measurements and Simulations of Temperature and Deformation Fields in Transient Metal Cutting. *J. Manuf. Sci. Eng.*, 125(4), pp. 645–655.

[26] SVOBODA, A., WEDBERG, D., and LINDGREN, L.-E. (2010) Simulation of metal cutting using a physically-based plasticity model. *Modell. Simul. Mater. Sci. Eng.*, 18(7), pp. 075005.

[27] POTDAR, Y.K., and ZEHNDER, A.T. (2003) Measurements and Simulations of Temperature and Deformation Fields in Transient Metal Cutting. *J. Manuf. Sci. Eng.*, 125(4), pp. 645–655.

[28] LI, J.-G., LU, Y., ZHAO, H., Li, P., and YAO, Y.-X. (2014) Optimization of cutting parameters for energy saving. *Int. J. Adv. Manuf. Technol.*, 70(1–4), pp. 117–124.

[29] YE, Y., HU, T., ZHANG, C., and LUO, W. (2018) Design and development of a CNC machining process knowledge base using cloud technology. *Int. J. Adv. Manuf. Technol.*, 94(9–12), pp. 3413–3425.

[30] MOHD ADNAN, M.R.H., SARKHEYLI, A., MOHD ZAIN, A., and HARON, H. (2015) Fuzzy logic for modeling machining process: a review. *Artif Intell Rev.*, 43(3), pp. 345–379.

[31] LI, X.X., HE, F.Z., and LI. W.D. (2019) A cloud-terminal-based cyber-physical system architecture for energy-efficient machining process optimization. *J. Ambient Intell. Humaniz. Comput.*, 10(3), pp. 1049–1064.

[32] KHATRI, B.C., RATHOD, P., and VALAKI, J.B. (2016) Ultrasonic vibration-assisted electric discharge machining: A research review. *Proc. Inst. Mech. Eng. Pt. B: J. Eng. Manuf.*, 230(2), pp. 319–330.

[33] BUCHKREMER, S., and KLOCKE, F. (2017) Compilation of a thermodynamics-based process signature for forming residual surface stresses in metal cutting. *Wear*, 376–377, pp. 1156–1163.

[34] SADEGHIFAR, M., SEDAGHATI, R., JOMAA, W., and SONGMENE, V. (2018) A comprehensive review of finite element modeling of orthogonal machining process: chip formation and surface integrity predictions. *The International Journal of Advanced Manufacturing Technology*, 96(9–12. pp. 3747–3791.

[35] CHAKRABORTY, S., JANA, T.K., and PAUL, S. (2019) On applying multi-criteria decision-making technique for multi-response optimization of the metal cutting process. *IDT*, 13(1), pp. 101–115.

[36] RESÉNDIZ-FLORES, E.O., NAVARRO-ACOSTA, J.A., MOTA-GUTIÉRREZ, C.J., and REYES-CARLOS, Y.I. (2018) Fault detection and optimal feature selection in automobile motor-head machining process. *Int. J. Adv. Manuf. Technol.*, 94(5–8), pp. 2613–2622.

[37] YAN, P., RONG, Y., and WANG, G. (2016) The effect of cutting fluids in the metal cutting process. *Proc. Inst. Mech. Eng. Pt. B: J. Eng. Manuf.*, 230(1), pp. 19–37.

[38] SHARIF, M.N., PERVAIZ, S., and DEIAB, I. (2017) Potential of alternative lubrication strategies for metal cutting

processes: a review. *Int. J. Adv. Manuf. Technol.*, 89(5–8), pp. 2447–2479.
[39] PERVAIZ, S., KANNAN, S., and KISHAWY, H.A. (2018) An extensive review of the water consumption and cutting fluid based sustainability concerns in the metal cutting sector. *J. Clean. Prod.*, 197, pp. 134–153.
[40] MORIWAKI, T. (2008) Multi-functional machine tool. *CIRP Annals*, 57(2), pp. 736–749.
[41] LU, Z., WANG, M., and DAI, W. (2019) Machined Surface Quality Monitoring Using a Wireless Sensory Tool Holder in the Machining Process. *Sensors*, 19(8).
[42] LU, Z., WANG, M., DAI, W., and SUN, J. (2019) In-process complex machining condition monitoring based on deep forest and process information fusion. *The International Journal of Advanced Manufacturing Technology*, 104(5–8), pp. 1953–1966.

参考文:

[1] SHAW，M.C. (2005) 金屬切削原理。牛津大學按需出版社。[在線的]。可用：https://books.google.com/books/about/Metal_Cutting_Principles.html?hl=&id=VxNiQgAACAAJ
[2] TRENT, E.M., 和 WRIGHT, P.K. (2000) 金屬切削操作和術語。金屬切削，第 9-20 頁。
[3] ALTINTAS, Y., 和 VER, A.A. (2001) 製造自動化：金屬切削力學、機床振動和数控設計。應用力學評論，54（5），第 B84-B84 頁。
[4] 多恩費爾德，D.A. (2012) 綠色製造：基礎與應用。施普林格科學與商業媒體。[在線的]。可用：https://play.google.com/store/books/details?id=XRqHvaKTXZYC
[5] GUPTA, K. (2019) 可持續製造創新。施普林格，2019。[在線]。可用：https://books.google.com/books/about/Innovations_in_Manufacturing_for_Sustain.html?hl=&id=9SZLvAEACAAJ
[6] PERVAIZ, S.、KANNAN, S.、DEIAB, I., 和 KISHAWY, H.（2020年）能源消耗、刀具和工件材料對環保加工的作用：綜合綜述。過程。研究所。機甲。英。鉑。 B: J. 工程。製造商，234(3)，第 335-354 頁。
[7] MUÑOZ, P.A.E., 和 CASALLAS, M.I.R. (2021) 工作幸福感與工作績效之間的關係：文獻計量分析、演變和趨勢。 虛擬雜誌北方天主教大學，64，第 241-280 頁。
[8] MUÑOZ, P.A.E., GÓMEZ, C.A.R., COLONIA, A.G., 和 SÁNCHEZ, N.E. (2019) 科學監督支持教育管理。培訓路線：實踐。經驗，9，第 21-35 頁。
[9] ARENAS，C.Z. (2020) 科學監督支持教育管理。培訓路線：實踐。經驗，10，第 60-75 頁。
[10] RAMOS-ENRÍQUEZ, V., DUQUE, P., 和 SALAZAR, J.A.V. (2021) 企業社會責任與創業：演進與研究趨勢。管理髮展，13（1），第 1-34 頁。
[11] ZUPIC, I., 和 ČATER, T. (2015) 管理和組織中的文獻計量方法。器官。水庫。方法，18（3），第 429-472 頁。
[12] TSENG, M.-L., TRAN, T.P.T., HA, H.M., BUI, T.-D., 和 LIM, M.K. (2021) 工業4.0的可持續工業和運營工程趨勢和挑戰：數據驅動分析。J.研究所。英。印度部分公關產品。英。第 1-18 頁。
[13] TIBERIUS, V.、SCHWARZER, H., 和 ROIG-DOBÓN, S. (2021) 激進創新：在已建立的知識和未來的研究機會之間。J.創新。知識，6(3)，第 145-153 頁。
[14] ANTE, L.、STEINMETZ, F., 和 FIEDLER, I. (2021) 區塊鍊和能源：文獻計量分析和審查。可再生可持續能源修訂版，137(110597)，第 110597頁。
[15] OBRADOVIĆ, T., VLAČIĆ, B., 和 DABIĆ, M. (2021) 製造業的開放式創新：審查和研究議程。技術創新，102（102221），第 102221 頁。
[16] WANG, R., SONG, Q., LIU, Z., MA, H., 和 LIU, Z. (2022) 基於傳感器融合的钛-6铝-4五薄壁零件銑削中的多條件識別.機甲。系統。信號處理，164（108264），第 108264 頁。
[17] MARUSICH, T.D., 和 ORTIZ, M. (1995) 高速加工的建模和仿真。詮釋。J. 數字。冰毒。工程，38（21），第 3675-

3694 頁。
[18] ÖZEL, T. (2006) 摩擦模型對加工有限元模擬的影響。國際機床與製造雜誌，46(5)，第 518-530 頁。
[19] MAEKAWA, K., OBIKAWA, T., YAMANE, Y., 和 CHILDS, T.H.C. (2013) 金屬加工：理論與應用。巴特沃斯-海涅曼，2013 年。[在線]。可用：https://play.google.com/store/books/details?id=p2LJOOfhaIIC
[20] MARUSICH, T.D., 和 ORTIZ, M. (1995) 高速加工的建模和仿真。詮釋。J. 數字。冰毒。工程，38（21），第 3675-3694 頁。
[21] LI, J.-G., LU, Y., ZHAO, H., LI, P., 和 YAO, Y.-X. (2014) 優化切割參數以實現節能。詮釋。J. 进阶。製造。技術，70（1-4），第 117-124 頁。
[22] HUANG, R., ZHANG, S., XU, C., ZHANG, X., 和 ZHANG, C. (2015) 類似子零件的靈活有效的数控加工過程重用方法。計算。援助德斯。申請，(62)，第 64-77 頁。
[23] HUANG, R., ZHANG, S., XU, C., ZHANG, X., 和 ZHANG, C. (2015) 類似子零件的靈活有效的数控加工過程重用方法。計算。援助德斯。申請，62，第 64-77 頁。
[24] YE, Y., HU, T., ZHANG, C., 和 LUO, W. (2018) 利用雲技術設計和開發數控加工過程知識庫。詮釋。J. 进阶。製造。技術，94（9-12），第 3413-3425 頁。
[25] POTDAR, Y.K., 和 ZEHNDER, A.T. (2003) 瞬態金屬切削中溫度和變形場的測量和模擬。J.馬努夫。科學。工程，125（4），第 645-655 頁。
[26] SVOBODA, A.、WEDBERG, D., 和 LINDGREN, L.-E。(2010) 使用基於物理的塑性模型模擬金屬切削。模型。模擬。母校。科學。工程，18(7)，第 075005 頁。
[27] POTDAR, Y.K., 和 ZEHNDER, A.T. (2003) 瞬態金屬切削中溫度和變形場的測量和模擬。 J.馬努夫。科學。工程，125（4），第 645-655 頁。
[28] LI, J.-G., LU, Y., ZHAO, H., Li, P., 和 YAO, Y.-X. (2014) 優化切割參數以實現節能。詮釋。製造技術，70（1-4），第 117-124 頁。
[29] YE, Y., HU, T., ZHANG, C., 和 LUO, W. (2018) 利用雲技術設計和開發數控加工過程知識庫。詮釋製造技術，94（9-12），第 3413-3425 頁。
[30] MOHD ADNAN, M.R.H., SARKHEYLI, A., MOHD ZAIN, A., 和 HARON, H. (2015) 加工過程建模的模糊邏輯：綜述。修订版，43(3)，第 345-379 頁。
[31] LI，X.X.，HE，F.Z. 和 LI，W.D. (2019) 基於雲終端的信息物理系統架構，用於節能加工過程優化。J. 環境智能。人性化。計算機，10（3），第 1049-1064 頁。
[32] KHATRI, B.C.、RATHOD, P., 和 VALAKI, J.B. (2016) 超聲波振動輔助放電加工：研究綜述。過程。研究所。機甲。英。鉑。工程製造商，230(2)，第 319-330 頁。
[33] BUCHKREMER, S., 和 KLOCKE, F. (2017) 基於熱力學的工藝特徵彙編，用於在金屬切削中形成殘餘表面應力。磨損，376-377，第 1156-1163 頁。
[34] SADEGHIFAR, M., SEDAGHATI, R., JOMAA, W., 和 SONGMENE, V. (2018) 正交加工過程有限元建模的綜合回顧：切屑形成和表面完整性預測。國際先進製造技術雜誌，96（9-12。第 3747-3791 頁。
[35] CHAKRABORTY, S., JANA, T.K., 和 PAUL, S. (2019) 關於多標準決策技術在金屬切削過程多響應優化中的應用。IDT，13(1)，第 101-115 頁。
[36] RESÉNDIZ-FLORES, E.O., NAVARRO-ACOSTA, J.A., MOTA-GUTIÉRREZ, C.J., 和 REYES-CARLOS, Y.I. (2018) 汽車電機頭加工過程中的故障檢測與最優特徵選擇。詮釋製造技術，94（5-8），第 2613-2622 頁。
[37] YAN, P., RONG, Y., 和 WANG, G. (2016) 切削液在金屬切削過程中的應用。過程。研究所機甲英鉑工程製造商，230(1)，第 19-37 頁。
[38] SHARIF, M.N., PERVAIZ, S., 和 DEIAB, I. (2017) 金屬切削加工替代潤滑策略的潛力：綜述。詮釋。J. 进阶。製造。技術，89（5-8），第 2447-2479 頁。
[39] PERVAIZ, S.、KANNAN, S., 和 KISHAWY, H.A. (2018) 對金屬切削領域

的用水量和切削液可持續性問題進行了廣泛審查。J. 清潔。產品，197，第 134-153 頁。

[40] MORIWAKI, T. (2008) 多功能機床。年鑑，57(2)，第 736-749 頁。

[41] LU, Z., WANG, M., 和 DAI, W. (2019) 在加工過程中使用無線傳感工具架監測加工表面質量。傳感器，19（8）。

[42] LU, Z., WANG, M., DAI, W., 和 SUN, J. (2019) 基於深度森林和過程信息融合的過程中復雜加工狀態監測。國際先進製造技術雜誌，104(5-8)，第 1953-1966 頁。