Review of Productivity Improvement by Implementing Automation in Manufacturing of a Grinding Wheel

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Abstract— Grinding wheels are made of natural or synthetic abrasive minerals bonded together in a matrix to form a wheel. For manufacturers, grinding wheels provide an efficient way to shape and finish metals and other materials. Grinding wheels are the only way to create parts with precision dimensions and high-quality surface finishes. At this time, grinding wheels are used in almost every industry. Manufacturing of a grinding wheel consist of mixing abrasive grains, binders and bonding materials. Three important components, abrasive grains with binders and bonding materials, make up any grinding wheel. The, additives are mixed to create a wheel with the properties necessary to shape a particular material in the manner desired. Abrasive grains include the central part of any grinding wheel, and the toughness and friability of the grinding materials will significantly affect the behavior of a given wheel. In the next step the ingredient mix is poured into the mold and compressed by a hydraulic press. Most grinding wheels are manufactured by the compression method, in which a mixture of components is pressed into shape at room temperature. The wheel is then fired at 200 0C – 1260 0C depending upon the type of the bond. The purposes of the firing are to melt the binder around the abrasives and to convert it to a form that will resist the heat and solvents encountered during grinding. Variety of furnaces is used to fire grinding wheels. After firing, wheels are moved to a finishing area, where holes are reamed to the specified size and the wheel circumference is made concentric with the center. Some work may be necessary to correct thickness or parallelism of wheel sides, or to make a special contour on the side or circumference of the wheel. Sometimes balancing of large wheels is necessary to reduce the vibration that will be generated when the wheel is spun on a grinding machine.

Key words: Automation, Grinding Wheel, resin piled wheels

I. INTRODUCTION

Grinding wheels have been important for more than 150 years. Today, grinding wheels appear in nearly every manufacturing company, where they are used to cut steel and masonry block; to sharpen knife, bits of drill tool, and many other tools; or to clean and prepare surfaces for painting. Moreover, the precision of automobile camshafts and jet engine rotors rests upon the use of grinding wheels. Sandstone, an organic abrasive made of quartz grains held together in cement, was probably the first abrasive; it was used to smooth and sharpen the flint on axes.

By the early nineteenth century, emery (a natural mineral containing iron and corundum) was used to cut and shape metals. By the 1890s, the search had yielded silicon carbide, a synthetic mineral stronger than corundum. Research into synthetic minerals also led to production of the so-called super abrasives. Foremost in this category are synthetic diamonds and a mineral known as cubic boron nitride (CBN), second in hardness only to the synthetic diamond. Today, development continues, and a seeded-gel aluminum oxide has just been introduced.

Figure: Grinding wheels

There are no specific performance standards for grinding wheels. In which some exception of those containing expensive abrasives such as diamonds are consumable items and the rates of consumption are different depending on application. However, a number of domestic and global standards are accepted, voluntarily, by manufacturers. Trade organizations, which represent some manufacturers in the highly competitive market, have developed standards including such matters as sizing of abrasive grain, marking of abrasive products, and the safe use of grinding wheels. The extent to which grinding wheel quality is checked depends upon the cost, size in diameter, and use of the wheels. Nowadays, wheel manufacturers measure the quality of incoming raw materials and their production processes to assure product consistency. Each large vitrified wheel is examined to determine the strength and integrity of the bonding system as well as the uniformity of grain through each wheel. Some tests measure wheel stiffness; hardness tests assure correct hardness of bonds; and spin tests assure adequate strength.

II. LITERATURE REVIEW

T. Tanaka & Y. Isono [1] this paper presents a unique method for developing a grinding wheel and polishing disk by piling and curing ultraviolet cured resin mixed with an abrasive grain. The presently discussed wheel manufactured is based on the application of rapid prototyping and technology in which the resin piled wheels are composed of piled layers of ultraviolet cured resin mixed with the abrasive grains. The grinding characteristics of a grinding wheel were analyzed by a grinding test. The cured depth and width of the ultraviolet light suffices to fabricate a small area of the grinding wheel surface.

Omar Fergani, Yamin Shao, Ismail Lazoglu, Steven Y Liang [2] Residual stress is a key factor that influences the reliability, precision, and life of final products. In this paper, a physics-based model is proposed to predict the onset temperature as a function of residual stress on an analytical and quantitative basis. The predictive model is based on the temperature distribution function using a moving heat source approach. Then, the thermal stresses are calculated analytically using Timoshenko thermal stress theory followed by an elastic-plastic relaxation condition imposed on these stresses, thus leading to the resulting residual stresses.

D. A. Axinte, J. P. Stepanian, M. C. Kong, J. McGourlay [3]. The paper reports on a particular application of AWJ turning that proved its technological and economic capability, i.e. Profiling and dressing of grinding wheels. Starting from the theoretical considerations, the key operating parameters of AWJ turning are identified and included in a methodology to generate various profiles of grinding wheels by means of tangential movement of the jet plume. a summary of the parameters of AWJ turning is presented along with an assessment of geometrical accuracy of profiled grinding wheels; additionally, evaluations of operational times to support the efficiency of the methods are presented.

M. J. Jackson, C.J. Davis, M.P. Hitchiner, and B. Mills [4] the basic mechanisms and the applications for the technology of high-speed grinding with CBN grinding wheels are presented. In addition to developments in process technology associated with high-speed machining, the grinding machine, coolant system, and the grinding tool also need to adapt to high-speed machining. Work piece-related factors influencing the results of machining are also discussed. The paper concludes with a presentation of current research and future developments in the area of high-speed grinding, and the development of high-speed CBN camshaft grinding.

Agnieszka Radziwon, Arne Bilberg, Marcel Bogers, Erik Skov Madsen [5] This paper reviews the usage of adjective smart in respect to technology and with a special emphasis on the smart factory concept placement among contemporary studies. Due to a lack of a consensus of common understanding of this term, a unified definition is proposed. The conceptualization will not only refer to various smart factory visions reported in the literature, but also link the crucial characteristics of this emerging manufacturing concept to usual manufacturing practice. Subsequently, the authors discuss the challenges of the potential smart factory applications in SMEs, and also propose a future research outlook in order to further develop the smart factory concept.

Kamal Kumar Mittal, Pramod Kumar Jain [6] Reconfigurable manufacturing systems (RMS) are considered as manufacturing systems that are capable of providing the exact functionality and capacity as and when desired. Unpredictable demand, requirement of variety of products, rapid development in product and process technology has forced the manufacturing systems to adapt the changing requirements efficiently. There are various performance measures like ramp-up time, cost, reliability, availability, lead time, reconfiguration time etc. that affects performance of the reconfiguration manufacturing system. This paper focuses on the performance measures and the way to find the best configuration for reconfigurable manufacturing system.

X.-Z. Xie, G.-Y. Chen, L. J. Li [7] in this paper, an acousto-optic Q-switched Nd: YAG pulsed laser is applied to dressing resin-bonded super abrasive wheels in orthogonal direction. The author proposes a systematical study on the mechanism of selective removal; crater ablated by single pulse and surface topography after dressing, and consequently presents a feasible method of selecting irradiation parameters and summarizes the dressing features and disciplines of dressing effects influenced by these parameters.

WANG Wei, YUN Chao [8] The flexible contact and machining with wide strip are two prominent advantages for the robotic belt grinding system, which can be widely used to improve the surface quality and machining efficiency while finishing the work pieces with sculptured surfaces. There lacks research on grinding path planning with the constraint of curvature. With complicated contact between the contact wheel and the work piece, the grinding paths for robot can be obtained by the theory of contact kinematics.

M.J. Jackson, M.P. Hitchiner, B. Mills [9] In order to maintain the integrity of the grinding wheel, the bonding system that is used to hold abrasive grains in place reacts differently to forces that are placed on individual bonding bridges. This paper examines the role of vitrification heat treatment on the development of strength between abrasive grains and bonding bridges, and the nature of fracture and wear in vitrified grinding wheels that are used for precision grinding applications.

HONG-SEN YAN A,HONG-YIH CHENG [10] In this paper, profiles of general pencil grinding wheels are applied as the generating surfaces for enveloping various variable pitch lead screws surfaces. Screws with and without meshing elements are studied. For screws with meshing elements, cylindrical, conical, hyperboloid of one sheet, and concave and convex involutes surfaces of the wheels are used.

III. CONCLUSION

From review of above literature we can conclude the following points:

- Not only hard and strong wheels, but also elastic wheels were obtained by the selection of resins with a proper bending strength and when elastic modulus is used as a grinding wheel.
- An increase of geometrical accuracy of profiles of the grinding wheels can be obtained using plain water jets.
- It has been shown that the development of vitrified CBN grinding technology is a collaborative partnership between end user, machine tool builder, and abrasive supplier Continued collaboration in addition to new developments in materials technology associated with abrasive products and camshafts will reduce grinding costs even further.
- Reconfigurable machine tools system would enable the system to adjust functionality and capacity according to feedback from demand and market fluctuations. The performance measures of the Reconfigurable manufacturing system gives an indication to choose the configuration in each stage.

The objective for my PG dissertation is to find out the causes of lower productivity in manufacturing of grinding wheel and try to reduce them as much as possible without exceeding cost limits.

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