

ERGONOMIC CONSIDERATIONS IN CNC MACHINE

Ayush Balagopal¹, Abhishek Yadav², Dheeraj Kumar Raja³, Deepanshu Shrivastava⁴
 ayushbalagopal96@gmail.com

^{1,2,3,4} B.Engg. Student Oriental College of Technology, Mechanical Department.

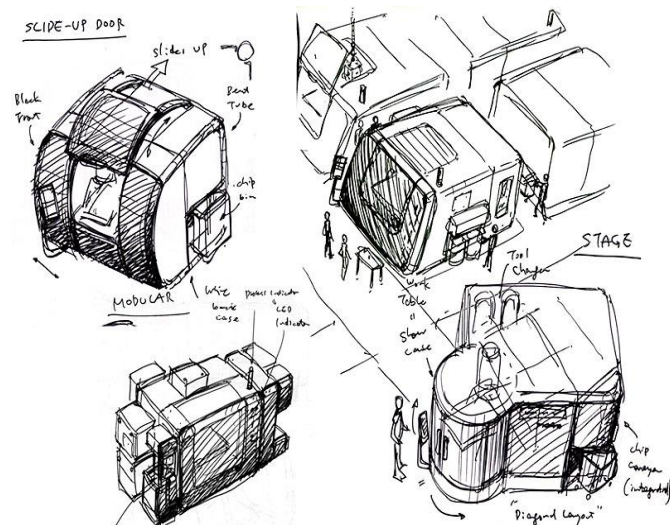
Abstract – In the new era of advanced manufacturing technology, machine tool design plays an important role in maximizing productivity and occupational health of industrial workers. However, the machine tool manufacturers face difficulty in designing an ergonomic machine tool that can be suited to Asian industrial workers and those with disability because almost all machine tools were designed according to physical dimensions, capabilities and limitations of European or American populations standards.

Current survey has showed that most people with disability and body disorder need equal work opportunity, while those with special needs may require special accommodations. Meanwhile, labor shortage is becoming more and more serious in existing manufacturing industry and there is less physical work involved in CNC machine operation. Thus it is a good opportunity for people with disability and disorder to work in manufacturing industry as CNC machines operators.

This mismatch between machine design and worker abilities may eventually lead to occupational injuries.

Key Words: Engineering Design, TRIZ, Ergonomics, Machining, Pinch Force, Occupational Injuries, Productivity, Manufacturing, Cumulative Trauma Disorders, Musculoskeletal Comfort

1. INTRODUCTION



Worldwide the machine tool industry is a small manufacturing sector, but widely regarded as a strategic industry as it improves overall industrial productivity through supplying embodied technology. The introduction of computer numerically controlled (CNC) has rejuvenated the market. The production and trade have been mostly concentrated in industrialized countries accounting for more than two-thirds of share. However, it is gaining importance among developing countries. The production of high-end machines is concentrated in the USA, Germany Switzerland and Japan. In the mid-range segment Japan is the market leader. In the low-end segment Taiwan and Korea are dominant.



1.1 ROLE OF ERGONOMICS

Ergonomics (Human Factors Engineering) is concerned with the 'fit' between people and their technological tools and environments. It takes account of the user's capabilities and limitations in seeking to ensure that tasks, equipment, information and the environment suit each user. To assess the fit between a person and the used technology, ergonomists consider the job (activity) being done and the

demands on the user; the equipment used (its size, shape, and how appropriate it is for the task), and the information used (how it is presented, accessed, and changed). The term 'ergonomics' is generally used to refer to physical ergonomics as it relates to the workplace (as in for example ergonomic chairs and keyboards). Physical ergonomics is important in the medical field, particularly to those diagnosed with physiological ailments or disorders such as arthritis (both chronic and temporary) or carpal tunnel syndrome. Ergonomics in the workplace has to do largely with the safety of employees, both long and short-term. Ergonomics can help reduce costs by improving safety. This would decrease the money paid out in workers' compensation. For example, over five million workers sustain overextension injuries per year.

1.2 CNC Machines (Milling) & Specification

CNC milling is a specific form of computer numerical controlled (CNC) machining. Milling itself is a machining process similar to both drilling and cutting, and able to achieve many of the operations performed by cutting and drilling machines. Like drilling, milling uses a rotating cylindrical cutting tool.



VMX42HSRTi

The SR series of 5-axis CNC mills offers multiple advantages, starting with the machine's design configuration that utilizes a swivel head with either an A or C style rotary table. The generous size of the rotary table provides maximum versatility because you can use the extra table space for secondary operations or 3-axis work.

Machine Specifications

X, Y, Z Axis Travel	42 x 24 x 24 in (1,067 x 610 X 610 mm)
B, C Axis Travel	+/- 90°, 360°
Spindle Nose to Table (Min-Max)	23.87 in max (606 mm max)
Table Size	50 x 24 in (1,270 x 610 mm)
Max Weight On Table	3,000 lb. (1,360 kg)

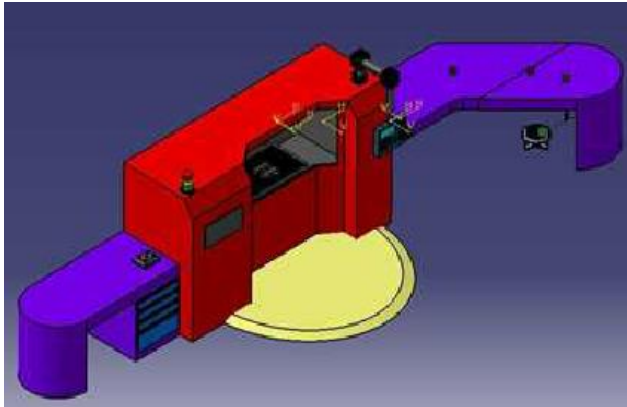
Max Weight on Rotary/ Trunnion Table	1,100 lb. (500 kg)
T-Slot Size	5 x .71 in (5 x 18 mm)
Peak Spindle Motor	47 HP / @ 2,800 rpm (35 kW / @ 2,800 rpm)
18k	88 ft-lbs (119 Nm)
Number Of Tools	40
Tool Type	HSK63
Max Tool Diameter	3.0 in (76 mm)
Max Tool Length	11.8 in (300 mm)
Max Tool Weight	17.6 lbs. (8 kg)
Max Programmable Feed rate	1,181 inches/minute (30 m/minute)
Rapid Traverse X,Y,Z Axis	1,378 in/min, 1,378 in/min, 1,181 in/min (35 m/minute, 35 m/minute, 30 m/minute)
Rapid Traverse A, C Axis	50 rpm, 100 rpm
Machine Weight	16,640 lbs. (7,550 kg)
Power Rating/ Full Load KVA	62 KVA
Required Floor Space	202.4 x 157.4 in (5,141 x 3,997.8 mm)

Optimum machine performance is reliant upon installation conditions at the facility, such as power supply, air supply, and ambient air conditions. Information may change without notice.

2. Ergonomical Design Of Control Knobs in CNC Milling Machines

The ergonomics of knob designs appear to play a role in the prevention of accidents musculoskeletal disorders, which can eventually affect the efficiency of work. Since there appear to be limited studies on ergonomic knob designs, researchers should study and work towards the design, development and assessment of an ergonomic knob that potentially reduces risks of hand-related injuries and musculoskeletal disorders. In manufacturing and machining industries, milling machines are common equipment which are often used to machine metal, wood and other solid materials. During the milling process, the control of the

milling tool's speed is vital in order to produce a good surface finish for the product. The speed is controlled by the milling machine speed control knob. Figure 1 shows an example of milling machine control knobs. However, in most cases, it is found that the milling machine control knob can be difficult to turn. The excessive amount of force used to turn the control knob repetitively could lead to the development of hand related musculoskeletal disorders in a long run.



2.1 . Industrial design analysis for CNC machine tools

Geometrical configuration and shape/form the appearance of machine tools must be reflected in the form of functions, such as performance function. The machine is an "organism," which is unlike other geometry. It contains internal functions, e.g. reflecting the beauty of the times. Design must respect the laws of art of the machines themselves, to ensure the machines' prime functions. Geometrical configuration and shape/form of the machine relate shape, proportion, balanced, textures at the machine. The machine industrial design in terms of geometrical shape/form is combined with the application of rules discussed in Section 2. Engineering should be looked on as guides. The use of textures should consider ergonomic and engineering based requirements affecting manual control functions, wear and corrosion.

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2.2 Interaction design

Human-machine interaction design can improve usability of machine tools, and play a significant role in creating higher value products. Good HMI design should improve brand image and operational efficiency of machine tools, also the operation mode should be more humane and rationalization.



Figure-Tongtai HA-500II



Figure-The FM 200/5AX Series



Figure-The Lead well LTC-208 & 210

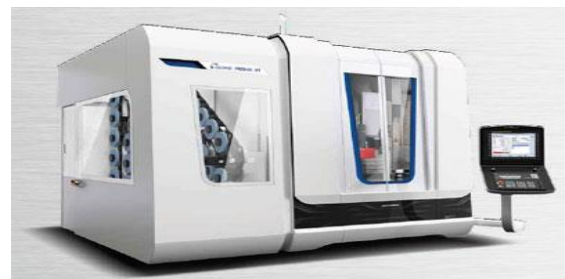


Figure-BLOHM PROKOS XT

A Tongtai HA-500II horizontal machining centre. It applies high torque output for heavy duty machining, with high acceleration and deceleration speeds of the feeding axes to shorten idle time. Taking aesthetically pleasing sheet metal design into consideration, the HA-500II machine has also improved its industrial design and user-friendly operation interface design. The FM 200/5AX Series adopts the concept of "sensitivity combined with robustness," which means that ergonomic designs are becoming increasingly important in the industry, The Lead well LTC-208 & 210 shows a multitasking lathe, which has a robust structural design that is ideal for heavy duty machining. The slant bed design provides the maximum rigidity and is designed for high production throughput environments so as to help users increase profitability by increasing productivity. BLOHM PROKOS XT is the product of United Grinding Co. The company is reforming the extreme precision of today's machines in other areas. The machine is in principle no longer a grinding machine, but a grinding-machining centre, can also undertake milling, turning and drilling operations.

3. Implementation and application perspectives through case studies

The redesign layouts for Ultra Mill are shown in Fig shows the machine tool design in a cubic shape with chamfered angles. The design uses slide-able doors for opening operations, the display control panel design and vertically film panel buttons. It not only meets the ergonomic requirements, but also increases the visibility through the observation windows. At the same time, the design reduces non-operational state of the machine footprint. The design layout shown is in cylindrical style with square shape, which uses straight-open door, and flexible touch-screen display. Flexible display section rotates within a pre-determined range. Machine users can adjust the height and position of the panel according to the users' needs. Therefore, it considers ergonomics while has modern fashion shape and design style. Although engineering issues have been taken into account when the program is presented, it still requires specialized engineering design before it is to be manufactured. At the same time materials processing methods and costs as well as user experience should be considered. Finally, by synthesizing and weighting all factors, designers will concretize, adjust or even replace the programs. The paper presents the ergonomic analysis of two programs.



Figure-The ultra-precision micro Milling

Research Scope

In a human-machine interaction environment, machines are used to aid humans in the execution of various tasks. Therefore, human-machine interaction system should be designed to match the capabilities, limitations and characteristics of human beings. This work demonstrated that the angle of abduction and viewing angle have a marked effect on the operator's performance.

CONCLUSIONS

In a human-machine interaction environment, machines are used to aid humans in the execution of various tasks. Therefore, human-machine interaction system should be designed to match the capabilities, limitations and characteristics of human beings. This work demonstrated that the angle of abduction and viewing angle have a marked effect on the operator's performance.

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Deepanshu Shrivastava is Pursuing Bachelor of Engineering Degree in Mechanical Engineering From Oriental College of Technology, Bhopal in the Year 2014-2018

BIOGRAPHIES

	<p>Mr. Ayush Balagopal is Pursuing Bachelor of Engineering Degree in Mechanical Engineering from Oriental College of Technology, Bhopal currently in 8th Semester. Published Journal in Industrial Ergonomics in IJITE Vol.33.</p>
	<p>Abhishek Yadav is Pursuing Bachelor of Engineering Degree in Mechanical Engineering From Oriental College of Technology, Bhopal in the Year 2014-2018</p>
	<p>Dheeraj Kumar Raja is Pursuing Bachelor of Engineering Degree in Mechanical Engineering from Oriental College of Technology, Bhopal in the Year 2014-2018.</p>