

Design and Application of CNC Machine Tools Based on Ergonomics

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Abstract

Through a brief analysis of some problems of ergonomics involved in the design of NC machine tools, this paper introduces the importance of ergonomics in the design of NC machine tools, so as to illustrate how to achieve the goal and accomplish the task safely, comfortably and efficiently, and then realize the perfection of people and products. Harmony and unity.

Keywords

Man-machine engineering; Numerical control machine; Modeling design.

1. Introduction

Ergonomics, or ergonomics, is the application of anthropometry, human mechanics, labor physiology, labor psychology and other disciplines of research methods, the study of human structural characteristics and functional characteristics, to provide the size of the human body parts, weight, body surface area, specific gravity, center of gravity and the human body in the activities of the relationship between the various parts of the human body. It also provides the human body function characteristic parameters such as the output range of each part of the human body, and the habits of movement, etc. It analyzes the functional characteristics of human sensory organs such as vision, hearing, touch and skin, and analyzes the physiological changes, energy consumption and fatigue mechanism of human in various kinds of labor. And people's adaptability to various labor loads; explore the factors that affect people's mental state in work and the impact of psychological factors on work efficiency[1-5].

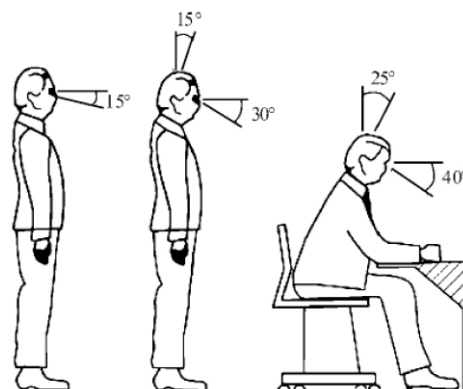


Fig. 1 best view angle of human body

CNC machine tools are designed with ergonomics principles to beautify the appearance of CNC machine tools and improve the working environment of staff. In the present industrial production of our country, the problem of man-machine engineering is not well considered in the stage of machine design, and the necessary experiment and Research on man-machine system is lacked. As a result, the machine is produced and put into use, it is discovered that the efficiency of the machine can not be brought into full play because of the unreasonable man-machine system, and even endangers the safety of the human body, and it pays a high price. It is difficult to improve the relationship between human and machine with a lot of time[6-7]. The design, transformation and application of NC machine tools show that the working quality of NC machine tools depends not only on the performance and quality of the machine itself, but also on the workers who operate it, and the labor

quality of the operators to a great extent depends on the functional quality of the man-machine system in the system[8-9].

CNC machine tool design takes design products as the main goal, more consideration is given to the realization of its own functions, although more or less involves human factors, but mainly considers how to make people adapt to the machine, and does not take people as a design goal, there is no standardized consideration of human factors. This is very difficult to ensure that the machine operation efficiency is the best, and it is not easy to judge the design quality. Ergonomics emphasizes that man and machine are the two basic parts of each other to form a whole, forming a man-machine system. Ergonomic design is a man-machine system, which takes man as a part of the system design and man-machine-environment as a system for overall design. Man no longer adapts passively to the machine, but completes a system goal together with the machine, thus can obtain the highest comprehensive efficiency of the system[10-13].

2. General Outline of Ergonomics

Ergonomics is based on the physiological and psychological characteristics of human beings, aiming at improving the quality of human work and life, using the viewpoints and methods of system engineering and information processing psychology, to study the interaction between human beings and machinery, human beings and environment, and between machinery and environment in the field of production, so as to simplify the design and operation, save labor, accurately and safely. The highly efficient and comfortable people, one by one, the environment system provides the scientific basis of theory and method. So it is also called "ergonomics", "ergonomics" and "ergonomics" in China. Man, machine and environment, which constitute the three main elements of man-machine system, can be regarded as three relatively independent subsystems of man-machine system, which belong to behavioral science, technological science and environmental science respectively. According to the first law of systems science, we know that the whole attribute of a system is not equal to the sum of some attributes, and its specific situation depends on the organizational structure of the system and the degree of synergy within the system. Therefore, the study of ergonomics should not only study the attributes of each subsystem of man, machine and environment, but also study the overall structure and attributes of man-machine system. In order to make the whole system safe and efficient, and have higher comfort and life support function for people, the ultimate goal is to make the system comprehensive use efficiency the highest[14].

3. Application of Ergonomics in CNC Machine Tool Design

In the design of modern man-machine-environment system, the whole relationship between machine and human must be considered. The design of the control mechanism first ensures that the control mechanism must be reliable and easy to use. When setting up the control mechanism, its quantity must be the most reasonable, and can prevent the accident in time when overloading or misoperation occurs. Therefore, the design purpose of the manipulator is to minimize the time-consuming of the functional operation process, the reasonable size ratio between the manipulator and the human body, the smallest energy consumed by the operator, and the reasonable setting of the control button, so as to enable the operator to operate the equipment in a relaxed, comfortable and pleasant environment, so as to avoid causing a lot of memory and attention to the operator. Overburdened. This requires that ergonomics analysis must be carried out in the design of the manipulator, so that the CNC machine tool can meet the most basic ergonomics standards of safety, easy repair and easy use.

The operation panel is the communication channel between the operator and the NC machine tool. As the human-machine interface of the NC machine tool, it realizes the information transmission between the person and the machine. In NC machine tools, the position between the control panel and the main machine depends on the size of machine equipment specifications. Generally, small-sized control panel of NC machine tools is placed on the fixed protective cover of the machine tools, so that the operator can operate and debug the machine more easily[15]. In large size NC machine tools, because the parts are large, in the initial stage of the parts processing and debugging, in order to

facilitate the debugging of the machine tools, programming and observing the cutting conditions of the parts, the machine tool console is set outside the machine tools, and can follow the operator along the length direction of the parts. And can swing in a certain range of angles, so it is necessary to consider the operator's workspace and working range in the design of the machine tool console structure, so that it can be comfortable to operate the machine tool.

Feng Guangyong and others found that when the display panel is mounted on the support arm, in order to ensure that the user's view is perpendicular to the screen, the panel should have a certain angle. When the display panel is fixed vertically, the height of the center point of the display screen should be less than or equal to the height of standing posture. If the panel is designed as an adjustable structure, its usability will be greatly improved. Which installation method should be adopted should be based on the overall modeling and functional requirements of the machine tool. Han Weiguo et al. have shown that when the CNC panel is perpendicular to the ground, the range of the best key area is closely related to the range of motion of the hand. For ease of operation, the best button area should be slightly higher than the standing elbow height, but lower than the standing eye height. Finally, the best button area is defined as 1153-1568 mm (Fig 2). When the CNC panel is tilted, the range of motion of the hand is affected, and the optimal key area is 974-1408mm (Fig. 3). Muthukumar et al. found that improper display of the machine could cause neck discomfort and improper panel controllers could cause shoulder and arm discomfort.

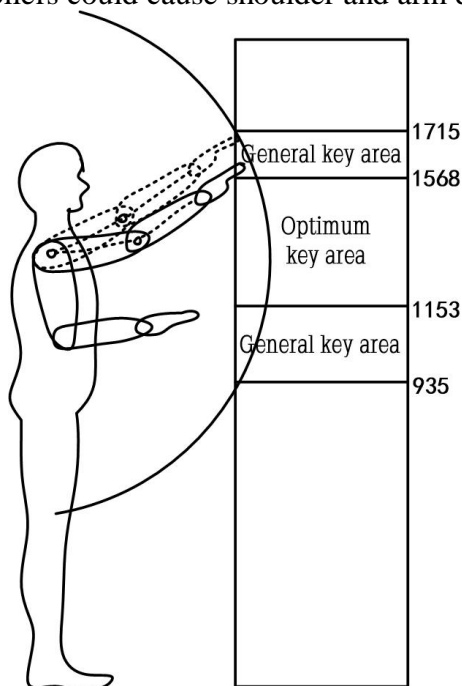


Fig. 2 vertical key interval

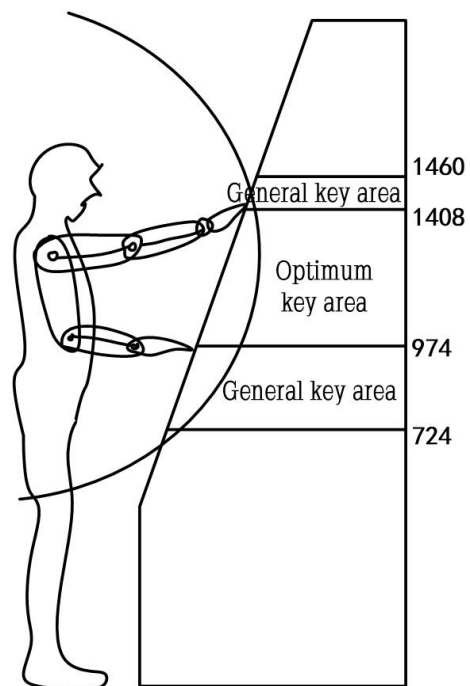


Fig. 3 tilt key interval

4. Application of Ergonomics in the Appearance Design of CNC Machine Tools

The essence of appearance modeling of NC lathe is the design of lathe protection, and the protection of NC lathe is composed of several design units, and each unit component is composed of specific components. Each design unit can be considered as part of the overall portfolio. For example, in the modeling design of NC lathe, the observation window is part of the lathe door, and the lathe door is part of the overall modeling of the lathe. The hierarchical structure relationship and combination of these modeling units can be shown in Fig 4. The sub components are made up of smaller components, thus forming a hierarchical relationship of CNC lathe protection.

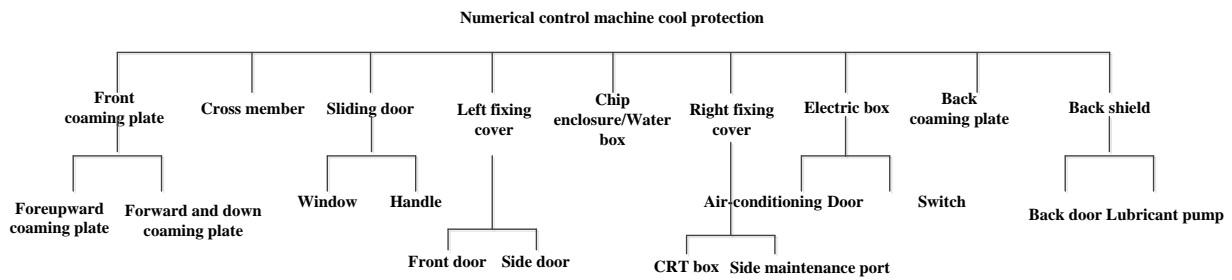


Fig.4 Protection level relationship of CNC lathe

In the modeling design of NC lathe, the overall modeling of the lathe is divided into several modeling units according to the requirements of the lathe protection layout, and the variable parts are found for each modeling unit. Variable parts of the change will lead to the change of each unit modeling, different modeling features of the appearance of the lathe units are arranged and combined to get a variety of lathe overall modeling style. Finally, through the evaluation of all possible schemes, it is necessary to consider the coordination of modeling features between the protective unit parts and the whole model, and between the protective unit parts and the unit parts, and to consider its structural factors, in order to get the modeling that meets the functional and structural requirements of the NC machine tools[16-18].

5. Application of Ergonomics in Unit Design

Modeling design of machine tool handle: The handle is very important in machine tool design, and the shape and installation position of the handle should consider the factors of ergonomics. In order to facilitate the use of the operator, the handle should be suitable for the size of the hand, so as to improve the comfort and efficiency of the operator. The length of the handle is usually controlled over 75 mm to meet the operator's requirements. **Modeling Design of Machine Tool Observation Window:** In the machine tool, the observation window is the part that the operator observes the workpiece and the movement of the machine tool. As the observation window of the machine tool vertical visual center, its shape has the finishing touch on the overall style. The handle is a part that the operator often contacts when operating the machine tool. It has certain influence on the comfort of the machine tool operation and the improvement of the working efficiency of the operator. In addition to the height of the handles, the diameters, lengths, shapes and materials of the handles should be considered from the perspective of tactile physiology. All of these should be in line with the size of the hand to make the grip comfortable and easy to operate[19-20].

The lathe pull door is an important modeling unit of the lathe appearance, and it is also the place where the lathe operator contacts more. Whether its size and structure is reasonable or not has an important impact on the ease of use of lathe operation. The design of lathe sliding doors should be combined with the left and right fixed covers of the lathe, and the size of the sliding doors should also be considered. The size of the sliding door should ensure that the maximum opening space of the sliding door is larger than the maximum size of the workpiece machined by the machine tool, and the corresponding allowance should be reserved. Horizontally, we must avoid the rope 200mm or so. If there is a manipulator, we need to deal with it as appropriate. For the lathe with the largest workpiece and the smaller one, the single door is usually used, while for the lathe with the largest workpiece and the larger one, the double door is usually used. When necessary, the door switches must be controlled by means of cylinders.

6. Conclusion

Fully using the research methods of ergonomics to study the appearance design of NC machine tools is the development trend of NC machine tools in the future. Many experiments and studies show that the man-machine factors play an important role in machine tool design. As far as machine tool modeling is concerned, the installation of control panel and handle has a suitable position range, the design of observation window and machine door has a scientific dimension basis, and in the overall

design of machine tool, the selection of appropriate linear and curved shape will also add color to the machine tool; as far as machine tool color design is concerned, it is necessary to use both low brightness and purity. High colors to keep the operator's attention, but also to use color decoration to enhance the operator's interest in work. Ergonomics is widely used in machine tool design. It combines "application" with "beauty", "technology" with "art". Some achievements have been made and a more humanized machine tool has been designed. However, there are still deficiencies in the existing machine tools, which need further study.

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