

A Review of Research on Ergonomics and Its Applications

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Abstract

In the contemporary ergonomics research has become a research hotspot in the field of design. This paper makes a summary of ergonomics research in recent years by focusing on ergonomics-related research, according to the many basic principles of ergonomics, starting from the research methods of ergonomics, explaining how to reasonably use the basic principles of ergonomics; and in the end, pointing out the importance of the use of ergonomics for future life.

Keywords

Man-Machine Engineering; Development Prospect; Application.

1. Introduction

Ergonomics is a key discipline that explores the structural and functional characteristics of the human body using research methods from the fields of anthropometry, human mechanics, labour physiology and labour psychology. This research provides parameters such as dimensions, weight, body surface area, specific gravity, centre of gravity, and interrelationships and accessibility of various parts of the human body during activity. Consideration of the "human factor" is essential in product design and manufacturing. Therefore, industrial designers should study and apply the theory and method of ergonomics in the design process to meet the requirements of human structural characteristics[1]. At the same time, with the development of the information age, the continuous progress of social science and technology has brought about a variety of new problems. In order to better address these challenges, ergonomics needs to cross disciplinary boundaries, introduce new technologies, update research methodologies, and expand the scope of practical applications, as well as to fully consider human development factors and conduct research on human-centred technologies and designs, in addition to which designers and researchers need to re-examine and understand ergonomics from a new perspective to adapt to the ever-evolving social and technological environments[2-5].

2. The content and methodology of ergonomics research

2.1 The content of ergonomics research

The study of ergonomics includes human characteristics, machine characteristics, environmental characteristics, the relationship between humans and machines, the relationship between humans and the environment, the relationship between machines and the environment, the relationship between machines and the environment, and the relationship between humans[6].

In the field of industrial design, ergonomics research is concerned with the design of human-machine interfaces, the design of console and control room layouts, the design of medical equipment, seating comfort studies, the design of office and office equipment, and the design of comfort for household products. The dimensions and proportions of products are determined through data studies, based on human physiological dimensions and usage habits. At the product development stage, ergonomics research data is applied to industrial design to ensure that products meet the needs of users and improve the experience and efficiency of use[7].

Considering the relationship between human-machine environment from all aspects and designing ergonomic products can improve work efficiency, comfort and safety.

2.2 Methods of ergonomics research

Research methods in ergonomics include: observational, empirical, experimental, simulation and modelling experiments, computer simulation, analytical, and survey research methods

Among the methods commonly used in the field of general industrial design are the following[8-10]:

Measurement Methods: Measurement methods are the main methods used in ergonomics to study the characteristics of the human form, which include scale measurements, dynamic measurements, strength measurements, volume measurements, muscle fatigue measurements and measurements of other physiological changes.

Model working method: This is an essential working method for designers. Designers can conceptualise the scheme, plan the scale, check the effect, find out the problems through the model, and effectively improve the success rate of the design.

Statistical survey methods: Many sensory and psychological indicators in ergonomics are difficult to obtain by measurement. Some of them, even if possible, are not necessary from the point of view of the scope of work of designers, therefore, designers often use survey methods to obtain this information. For example, a macroscopic study of the life patterns of 1,000 people per year is conducted on an ongoing basis, collecting and analysing personality traits, consumer psychology, use of personality, diffusion of roles, media exposure, use of everyday objects, design preferences, allocation of time for activities, use of domestic space and demographic measurements, and a corresponding database is built up. The results of the surveys, although more difficult to quantify, give an intuitive and sometimes more effective picture.

Methods of processing and analysing experimental data: when the designer measures or investigates a population, the results will have a certain degree of dispersion, and must be analysed and processed using mathematical methods, in order to be transformed into a database of applied value, which will have a guiding significance for the design.

3. Characteristic breakdown study of ergonomic content

3.1 Study of human factors and human characteristics

Human factors are analysed and studied to optimise ergonomics, safety, economy and comfort of the human-machine system.

The main research includes:

- (1) Hardware ergonomics of machine adapting to human, mainly studying anthropometrics, work domain (human working posture, seat, display/controller, environment) ergonomics design, etc;
- (2) The software ergonomics of machine adaptation to human, mainly studying the ergonomics law and design method of optimal matching of human-computer-display system;
- (3) Cognitive ergonomics of machine adaptation to human, research on the ergonomics of information interaction and decision-making between human and information system and system design, so that the information system can adapt to the cognitive process of human.

3.2 Research on machine characteristics

Research on ergonomics-related machine characteristics and their modelling techniques.

3.3 Research on Environmental Characteristics

Research on ergonomics-related environmental characteristics and environmental modelling techniques.

3.4 Human-Organisation System Research

It mainly includes three aspects:

- (1) Static human-machine system research mainly has the layout and design of operation domains
- (2) Dynamic human-machine system research mainly includes human-machine function allocation research (human-machine function comparison research, human-machine function allocation method research, and artificial intelligence research).
- (3) Human-machine interface research (research on human-machine interface design and evaluation technology for display and control).

3.5 Human-environment relationship research

Research on the influence of environmental factors (low air pressure, gravity, temperature and humidity, lighting, noise, etc.) on human beings, protection and control methods of environmental adaptation to the life and work of human beings, etc.

3.6 Research on machine-environment relationship

To study the machine-environment relationship and characteristics related to ergonomics.

3.7 Research on the overall performance of human-machine-environment systems

It mainly includes the research on the overall mathematical model of human-machine-environment system, the research on the full mathematical simulation, semi-physical simulation and full physical simulation technology of human-machine-environment system, the analysis, design and evaluation of the overall performance (safety, efficiency and economy) of human-machine-environment system, and the role of virtual reality technology in the research of overall performance of human-machine-environment system. environment system overall performance (safety, efficiency, economy) analysis, design and evaluation, the role of virtual reality technology in the research of human-machine-environment system overall performance.

4. Research on ergonomics in related applications

In people's daily life, they often encounter situations that require judgement and simplified operation, but the designers have not considered or are not familiar with the application of ergonomic principles, thus causing inconvenience to the users. This situation is common in the design of various products and the layout of interfaces.

If ergonomics principles are integrated into product design, the effect of enhancing product ease of use and user experience can be achieved.

4.1 Microenvironmental ergonomics research

It is the field of the effects of temperature, air humidity, airflow, light and other factors on human beings. Factors in the microenvironment have a significant impact on human productivity, safety and comfort. Ergonomics is applied in microenvironments, especially in light environments. A good light environment not only improves human visual conditions (lighting physiological factors), but also improves human visual environment (lighting psychological factors), which leads to higher productivity and lower error rates. In addition, a good light environment also helps to reduce the rate of accidents and protect the vision and safety of staff.

It can be seen that through the study and application of ergonomics to microenvironments, a more suitable and safe working environment can be created, enhancing work efficiency and the work experience of employees.

4.2 Switch Setting

When configuring multiple lighting fixtures in a large space, such as a classroom, sometimes it is not necessary for all the lighting fixtures to be switched on, but only partially lit. However, due to the irregularity of the position of the lamps and the switching sequence, it is difficult for the user to quickly find the correspondence, leading to a waste of time and power. According to ergonomic principles, this problem can be solved by using a staggered design of switches. This staggered design can improve the user's operating efficiency and save time and resources.

In ergonomics, designing ergonomic control handles, buttons and other devices can significantly improve efficiency. If users can easily find and operate the switch, it not only saves time, but also reduces energy waste. Therefore, when designing light switches, the user's habits and ease of operation should be taken into account, so that the switch position is orderly and ergonomic to enhance the user's operating experience and work efficiency. In turn, through the ergonomic design principles, the switch settings of large space lighting equipment can be effectively improved, so that users can control the lighting more conveniently, thus improving work efficiency and saving energy.

4.3 Setting of the operating desk

An ergonomic operator's console design provides a comfortable working environment when people are working, observing and controlling from a seated position. The design of the operating console should take the following points into consideration:

- (1) Console height: The height of the console should be below the level of the human eye line when sitting to ensure a comfortable working posture.
- (2) monitor settings: the required monitors and controllers should be set on a panel with a slope of 20° to facilitate observation and operation. When the number of monitors is large, they should be designed as high desktop consoles and configured in zones according to their importance.
- (3) Slope setting: According to the principle of ergonomics, the slope of the design panel should comply with the following specifications:
- (4) Primary monitors: set within 10° above to 30° below the line of sight, with a slope of 10° .
- (5) Secondary display: set within the range of 10° to 45° above the line of sight, with a slope of 20° .
- (6) Controller: set within the range of 30° to 50° below the line of sight, with an inclination of 35° .

If the design of the operating table does not comply with the above principles, it will lead to uncomfortable operation and observation, which in turn will affect the accuracy of the work. From this, it can be seen that when designing the operating desk, ergonomic norms should be followed in order to provide a comfortable and efficient working environment.

4.4 Installation of Engineering Signs

The design of engineering signs plays an important role in conveying information in a clear and concise manner on many occasions. In some cases, where it is not possible to use extensive textual descriptions or there is no time to read text, specific information can only be conveyed through graphics or symbols. In the field of traffic management, such as railways, roads, civil aviation and water transport, the use of distinctive graphic symbols as road signs is a very effective safety management measure. These signs can remind people of specific information, guide them to act according to regulations and improve traffic safety.

In addition, engineering signs are also widely used on production equipment to indicate the content, location and direction of operations. With clear and concise symbols or graphics, operators can quickly understand the operation steps or required actions, improving work efficiency and accuracy. The design of engineering signs can not only simplify the communication of information, but also reduce the occurrence of misunderstanding and operation errors, which is of great significance to improve work efficiency and safety.

To sum up, engineering logo design plays an important role in various fields, and through reasonable design of graphic symbols and symbols, it can effectively convey information and improve work efficiency and safety management.

5. Problems of ergonomics research in industrial design at present

In the context of the continuous updating of products, ergonomics research still faces many problems in product design. Although "humanised products" and "ergonomic factors" are both product design principles closely related to people, there are still challenges due to the fact that people's physical needs and psychological factors are closely related to social development. The difference in

anthropometric data between China and foreign countries leads to the fact that product design cannot simply quote foreign data.

Some industrial designers pointed out that in the design of computer accessories, such as input devices like keyboards and mice, the differences in the habits of different users are not adequately taken into account, resulting in the problem of homogenisation of product design. The different needs of people of different geographic regions, ages, occupational backgrounds and educational levels should be taken into account, and the existing ergonomics research data are too homogenised. To solve this problem, ergonomics research data needs to be more segmented to better meet the needs of different groups. For example, in mobile phone design, the focus of ergonomic factors needs to be different for different age groups of consumers. For product designers, it is important to ensure that products are designed to be aesthetically pleasing, durable and easy to use in all conditions, and to maintain a good human-machine relationship to meet the needs of different groups.

6. Outlook

In the context of the information age, the technological, economic and cultural changes of the information age have a direct impact on the development of ergonomics. At present, with the continuous emergence of human-computer interaction interface and virtual reality technology and other fields, the research of ergonomics is also gradually showing the characteristics of interdisciplinary diversification. In the face of the diversification of research content, methods and participants, designers and researchers need to consider the problem comprehensively from a wider macro ergonomics perspective to ensure the accuracy and timeliness of the research results.

Ergonomics, as a systematic approach, will effectively solve the problems related to people, machines and the environment. The research object will be continuously expanded, and new things will be included in the scope of the research, involving many cross-disciplinary fields. The research will gradually strengthen the systemic nature, comprehensively consider the mutual influence and constraints between different factors, and view the problem from a more macroscopic socio-technical level. The research means and methods of ergonomics will be constantly updated, new technologies such as virtual reality will be widely used, and interdisciplinary cooperation will provide diverse and rich research methods, so that ergonomics can more effectively solve various man-machine problems.

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