

Design and practice of target reporting machine based on Ergonomics

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Abstract: Based on the simulation analysis and design evaluation of ergonomics, the ergonomics design status of the same type of instruments in the market was analyzed. The design index is obtained through interview and investigation. Finally, the design elements are summarized and mapped, and the design scheme is proposed. After the physical prototype is completed, the evaluation and discussion are made, and the optimization and improvement of the human-machine interface are started. The elements of the relationship between human, machine and environment are discussed, and the design idea of special electronic instrument based on ergonomics is constructed, which promotes the interdisciplinary application development of ergonomics and product development.

Key words: human machine interface; Experimental simulation

With the rapid development of the world and the rapid development of science and technology, the way of human life is also gradually changing with the progress of the times. 5g, Internet +, 3D scanning, intelligent devices and other products are no longer exclusive to military, so they are slowly moving towards civilian use. In the process of product design and development, special instruments and electronic equipment focus on the design and implementation of technology, while the design of ergonomics has been ignored for a long time.

Therefore, it is very necessary to study and design a new type of instrument and equipment to provide the target reporting process. This instrument and equipment has modern technology and is relatively simple to operate. It should be efficient, practical and accurate for shooting trainers and logistics personnel. Provide a more scientific and reasonable ergonomic design process and method for the appearance size and interface design of special instruments, and promote the maturity of the overall design of such special instruments.

1. Design idea and scheme analysis of target reporting machine

Through the analysis of the relevant technical standards and the investigation of the operating environment, the design of the target reporting machine was evaluated experimentally, and the usability results of each part of the fuselage design of the target reporting device were obtained. From the feedback of the experimental results, the appearance, the structural design of the detail parts, and the human-machine interface were analyzed. The target reporting machine is designed by using the theory of ergonomics, and the design scheme in line

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with the engineering practice is obtained, that is, the product is developed and designed by using ergonomics.

1.1 design scheme

The design form of the scheme should be relatively simple. The bottom adjustment and the instrument body are separated, which can better adapt to the operation of calibration target. The overall design semantics are mainly geometric modeling. As shown in Figure 1.

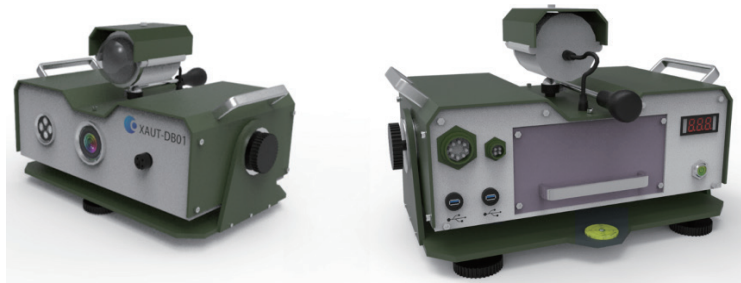


Fig. 1 Effect Drawing

1.2 specific analysis of final scheme optimization design

The design and analysis of similar instruments are carried out from the human-machine size, appearance modeling, and human-machine interface, and then the actual design work is started, including modeling, drawing, deliberation, detail description, and model display.

1) Handle design

When optimizing the design of the handle, it is comprehensively designed in combination with the environment, working mode and other factors. The design with double handles as the scheme is more suitable for the handling of the instrument after the overall size and size of the target reporting equipment are evaluated.

2) Horizontal column design

When the target reporting equipment is placed on the ground during training, the operator needs to squat down to level the equipment. The distance between the line of sight and the human-machine interface is appropriate, and the position of the horizontal column is easier to observe, which is convenient for the operator to operate and calibrate.

3) Modeling semantics and appearance

In the appearance of the optimized target reporting equipment, the shell structure is separated from the base design, which not only controls the production cost, but also provides convenience for the processing technology. The leveling part of the base has certain requirements for the technology and time control of the equipment operated by the operators in actual use, so the design is suitable for engineering practice.

4) Design of laser working interface of equipment

According to the experimental evaluation of the on-site situation, most operators believe that the adjustment angle of the fuselage should be simple and direct, just aim at the target center. According to the material selection and process analysis of the physical prototype, as well as the effective distance between laser work and camera calibration, the angle adjustment device using the damping shaft is determined, as shown in Figure 2.

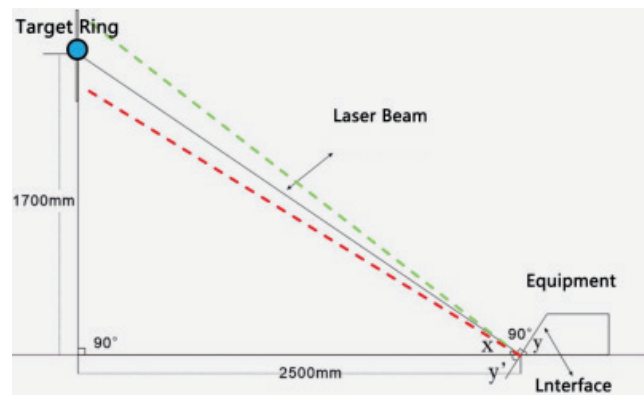


Fig. 2 Schematic diagram of relative position between target reporting equipment and target paper

2. Process design scheme of target reporting machine

The manufacturing quality and cost of non-standard equipment mainly depend on its process and manufacturing scheme. Generally speaking, the higher the requirements of equipment process and manufacturing scheme, the higher the final manufacturing cost will be. Therefore, how to optimize the process scheme of the equipment, properly handle the high requirements of the equipment manufacturing process, and design a functional structure scheme that not only meets the final operation, but also has low requirements for the components

of the functional structure is very important.

2.1 internal structure design of equipment

While optimizing the appearance design, the internal structure of the target reporting equipment is also designed and arranged. The scheme optimizes the internal structure, man-machine interface, buttons and interfaces. The internal structure is mainly composed of four parts, namely, industrial control computer, circuit board, line collecting and distributing device, and connecting harness of each component. The overall design is optimized.

2.2 material selection and process

The working environment of the target reporting equipment is different from that of other instruments. Generally, the experimental equipment does not need frequent handling, and the surrounding climate is safe and stable, so a large number of plastics can be selected as the production material. As the target reporting equipment often works in harsh environment, it has a certain protective effect on shrapnel, rain and snow, wind and sand, and the lighter the overall mass, the better. Therefore, aluminum alloy material is selected.

2.3 key points of regulating mechanism design

1) Design of bottom leveling mechanism

After the confirmation of ergonomics analysis and functional requirements analysis, it is concluded that the target reporting machine should have the structural characteristics, and the external of the instrument should have an auxiliary device that can adjust the balance in a short time. During normal operation of the target reporting machine, the fuselage shall be placed between 1 m and 1.5 m in front of the target paper.

2) Design of fuselage side angle adjusting mechanism

The base design of the target reporting equipment is separated from the fuselage itself. The overall appearance and structure design of the fuselage has no adjustment device, and there is no way to achieve angle adjustment and balance. Therefore, the base and the machine are separated to achieve the relative angle adjustment between the fuselage and the base.

2.4 color analysis and rendering

After the drawing and deduction of the sketch, the overall external shape and structure of the target reporting machine were designed. 3D modeling further restored the sketch, and the basic shape and appearance of each component were fully displayed on the sketch and preliminary design. The semantics of appearance modeling is determined based on the analysis of the design requirements of the target reporting machine and human factors. The overall fuselage uses the most straight lines.

2.5 realization of physical prototype production

After communicating and researching with engineers and experts, a functional prototype was developed to meet the functional requirements of the target reporting machine. The processing technology and shell material are metal sheet metal parts. The color of the prototype is determined to be military green, which conforms to the outdoor shooting training environment color of most military and police, and is matched and integrated with camouflage and other military and police equipment, highlighting the sense of dignity, specificity and mecha of the target reporting equipment, and delivering a positive impact to the operators.

3 man machine experiment analysis

3.1 evaluation method

This experimental evaluation is based on the realistic simulation of ergonomics, and the main method is video, photography, data recording, feedback recording, and the summary and analysis of feedback results. During the whole cycle of operation and feedback, a set of evaluation methods for ergonomic design are formed.

3.2 contents of work efficiency evaluation

The contents of the evaluation are divided into six categories, namely, the evaluation of the height adjustment module of the fuselage of the target reporting equipment, the evaluation module of the vertical angle adjustment of the laser interface of the target reporting equipment, the evaluation module of the operation time and difficulty of the human-computer interface, the evaluation of the convenience of the handle in the process of carrying the target reporting equipment, the evaluation of the adaptability of the color design of the target reporting machine in the shooting range. Evaluation of the impact of target reporting machine material on people in the shooting range.

3.3 evaluation object and equipment

1) Evaluation object

The evaluation objects are military and police units and civilian shooting range trainers. The experimental evaluation objects are soldiers in active service and other logistics operators aged 18-42 years old. The number of people participating in the work efficiency evaluation is 30, all of them are normal adult males, with a weight distribution of 116-158, and the body function is at the normal level. There are no injuries to the limbs, normal visual function, no myopia, color blindness. Have good learning ability and the ability to operate machines alone.

2) Evaluation equipment

The equipment used in the evaluation experiment is the first generation physical prototype of the target reporting equipment which has completed the innovative design and development.

3.4 process and results of experimental evaluation

As shown in Table 1, the time for the experimenter to operate the equipment is recorded, which is the time record between turning

on the equipment and letting the equipment enter the working state. After the equipment transported from the warehouse is placed on the ground, the height and angle are adjusted until it meets the working requirements with the front target. The opening time of the device is (s): 40, 34, 37, 39, 40, 36, 35, 32, 36, 45, 41, 37, 36, 40, 41, 34, 39; Adjust the equipment time as (s): 21, 23, 19, 26, 23, 22, 18, 18, 22, 18, 29, 22, 30, 18, 19, 20, 18.

After the process of handling - angle - height adjustment - start - start, the equipment enters the working state, as shown in Figure 3, which is the real picture of the target reporting equipment after the switch has been turned on and all interfaces have been connected.



Figure 3 target reporting equipment about to enter the working state

This group of experiments can obtain the comfort of people in handling, and evaluate the overall man-machine size, handle size, installation position and other information of the target reporting equipment. In the experimental part of squatting operation, the height, angle and comfort of the debugging equipment were recorded respectively. According to the experimental evaluation of the target reporting equipment, the first generation of physical prototype has met the requirements of engineering application, and met the design requirements of ergonomics. The evaluation results of the design comfort, appearance size and color design of various regulating devices are all well fed back. The design content with a large proportion of dissatisfaction in the work efficiency evaluation is analyzed and redesigned to provide theoretical and practical basis for the design improvement of the next generation prototype.

4. conclusion

In this paper, the overall design of the target reporting machine is taken as the research object, and its operation process, appearance design, processing technology and so on are analyzed and designed in detail by using the design method of man-machine efficacy. The evaluation index method of man-machine efficacy of special electronic equipment is constructed, and the specific underlying qualitative and quantitative evaluation indexes are extracted. At the same time, the quantitative methods of objective and subjective evaluation indexes and the calculation of weight value are studied. According to the selection of processing technology, materials and structure of the product, the special electronic equipment for target reporting machine is improved and designed. By comparing the experimental data of ergonomics, a product design idea is provided.

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