



# Research on water special life jacket based on AEIOU method

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**Abstract.** Through the design and research of the water special life jacket, to provide better rescue equipment for rescuers, to solve the problem of high casualty rate and low success rate of rescue operations. The AEIOU approach is used to assess the crucial components of water rescue, research the behavior of rescuers when interacting with specific individuals or items, and then synthesize their requirements. The design strategy for a water-specific life jacket uses requirements as the design orientation and ergonomics as the design criterion. By using the rescue action record of rescuers based on AEIOU method, we can effectively explore the needs of rescuers and rescued, and build a unique life jacket for water with strong safety, good rescue, and high comfort. The water life jacket is designed to ensure the safety and comfort of the rescuers while effectively shortening the rescue time and improving the success of the rescue.

**Keywords :** Life jacket, water rescue, AEIOU method, ergonomics

## 1 Introduction

In recent years, there is a rising trend of water warning due to extreme climate. With the increasing social attention, many professional water rescue teams have been set up in China, but the research, development and use of rescue equipment still lag behind, resulting in a low success rate of rescue operations and a high casualty rate of rescuers [1].

Water special life jacket is necessary equipment to carry out rescue activities, which has been studied by many scholars. Wang Shanchao et al. designed a new inflatable warm life jacket in view of the lack of warm life jacket [2]. Li Peizhong et al. built a device with AIS positioning and launching functions into the life jacket, and designed an intelligent life jacket with positioning alarm [3]. In summary, the research mainly focuses on functional optimization and mechanical structure, and lacks the design and study of interactive behavior between rescuers and rescued, and the extraction of user needs is insufficient. Therefore, this study used AEIOU method to record and analyze

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the key steps of water rescue, fully explore the needs of users, and put forward the design strategy of water special life jacket based on the needs as the design guide.

## **2 Overview of the AEIOU method**

The AEIOU method was established by Robinson et al in 1994 as a systematic method for observing, recording, and analyzing the behavior of research subjects [4]. The AEIOU method has several elements: Activity, Environment, Interaction, Object, and User. Activity refers to a series of goal-oriented behaviors of the research object; Environment refers to the place where the research object conducts its activities; Interaction refers to the interaction between the research object and other people or things; Objects refer to all objects that interact with the object of study; Users are all the people involved in the activity. The process of design is actually the process of coordinating the relationship between the user, the product and the environment. The AEIOU method can be used to comprehensively and meticulously record the user's environment during an activity, as well as the interaction between the user and people or objects in this environment, extract and summarize the user needs, and transform the needs into design objectives.

## **3 Water special life jacket design process based on AEIOU method**

### **3.1 Identify target users**

The rescuers are men in their 20s to 40s who directly use lifejackets for water. The rescuer is selected as the target user, and a series of activities in the rescue process are recorded by AEIOU method, so as to find the pain points and opportunity points in the design of special life jacket for water.

### **3.2 Analyze user activity**

The rescue action records of rescuers according to the AEIOU method are shown in Table 1. When the water rescue is carried out, the shore rescue should be preferred if the conditions permit, and the existing life-saving equipment should be used to rescue the sober trapped people [5]. If there is no available life-saving apparatus, or the trapped person is in a state of extreme stress or even coma, it is necessary to use the way of water rescue. Therefore, the activities of rescuers can be divided into the following stages: finding the rescued, entering the water to approach the rescued, controlling the rescued, and dragging the rescued ashore.

**Table 1.** Records of rescuers' rescue operations based on the AEIOU method

Activity	Environment	Interaction	Object	User
Found the rescued	Shore	Quickly put on a life jacket, assess the condition of the person rescued, and choose the appropriate rescue tools	Life jackets, Rescue tools	Rescuer, Rescued
Enter the water and approach the rescuer	In water	Overcome the current resistance and swim quickly to the trapped person, paying attention to avoid complex current patterns and underwater obstacles	Life jackets, Rescue tools	Rescuer, Rescued
Control the rescued	In water	Approach the person from behind, restrain the person and put on a life buoy or other rescue tool	Life jackets, Rescue tools	Rescuer, Rescued
Return to shore with the rescued	In water	Drag the rescuer in a backstroke position and bring yourself and the rescuer safely back to shore with the assistance of shore teammates	Life jackets, Rescue tools	Rescuer, Rescued, Helper

### 3.3 Capture user requirements

Table 2 shows the needs of rescuers in each rescue operation and the problems with existing life jackets. Through the analysis of a series of rescue action records of the above rescuers, extract and summarize the needs of users, and correspond to the existing problems of special life jackets in the existing waters.

**Table 2.** Analysis of user needs and product problems

Interaction	User demand	Problem
Put on your life jacket quickly	Keep the life jacket firmly attached to the body by taking as few steps as possible	The adjustment buckle is not effective and it is difficult to adjust the life jacket to the right size
Avoid complex current patterns	Life jackets can provide sufficient buoyancy without affecting the flexibility of movement	At present, most lifejackets for water use are made of solid buoyancy materials [6], which provide unchangeable buoyancy. It is difficult to find the balance between the buoyancy required by calm waters and the buoyancy required by complex waters
Avoid underwater obstacles	Avoid being hit by underwater obstacles	Solid buoyancy materials have limited impact mitigation

Control the rescued person and put on a life buoy	Rescue tools are easy to carry and easy to fasten on the person being rescued	The original buoyancy of the life jacket cannot support the weight of two people, rescuers need to carry an extra rescue tool. But existing rescue tools are too large to be carried around or secured to a trapped person
Safely ashore with the assistance of his teammates	Communicate with teammates in a timely and effective manner	Position indicator lights, whistles and other devices are difficult to use in the water environment, resulting in the rescuers can not timely convey information

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### 3.4 Propose design strategy

In view of the problems existing in the existing water special life jacket, the following design strategies are put forward: (1) Add anti-drowning components. The life jacket adopts the buoyancy supply mode of the combination of solid buoyancy material and gas buoyancy material. Solid buoyancy material evenly distributed around the waist of the rescuers, to ensure that the rescuers in general water conditions above the chest can be exposed to the water [7]; The gas buoyancy material (inflatable air bag) is placed on the shoulder of the rescuer. The air bag can automatically inflate according to the water depth change, so as to ensure that the rescuer can float up quickly after being sucked into the complex water flow. (2) Add additional anti-collision parts to key areas of the body, such as the chest, back and elbows. The material of the anti-collision parts shall be plastic with light weight, high strength, good toughness and easy processing and forming [8]. (3) Add a water entry rescue tool attached to the life jacket. The tool is to be inflated before use. When the rescuer fixes it on the body of the rescuer, the tool can be inflated quickly. (4) Optimize the design of position lamp and whistle. For example, the position lamp can automatically glow when it meets water, and the rope can automatically recover after the whistle is used.

## 4 Design practice of water special life jacket based on AEIOU method

The lifejacket is supported by an elastic, body-tailored garment with solid buoyancy part, anti-drowning part, back anti-collision parts, elbow anti-collision parts, chest anti-collision parts, rescue tool, PFD quick release device, life whistle and position indicator lamp attached to the garment through the corresponding structure. The specific distribution of each component is shown in Figure 1.



**Fig. 1.** Distribution diagram of each component

#### 4.1 Structure and form design of solid buoyant part

The natural buoyancy components are the main components that provide buoyancy and are made of polyethylene foam wrapped in a waterproof fabric. This piece consists of three parts, one on the left side of the chest, the right side of the chest, and the back. The front two parts are connected with the back part through elastic material to ensure that the life jacket has a certain inclusiveness.

#### 4.2 Structure and form design of anti-drowning part

The anti-drowning part adopts an inverted U-shaped structure that fits the curve of the shoulder and neck of the human body, and adopts a fixed way combining fastenings and Velcro to make the whole component fit with the life jacket. The anti-drowning component is an inverted U-shaped structure with large front and small rear after aeration. Such a more forward and less back buoyancy distribution mode, more conducive to rescue workers in danger after floating face up on the water [9].

#### 4.3 Structure and form design of anti-collision parts

The back anti-collision part adopts the form of the imitation spine, which is composed of six small parts. There is a certain displacement space between the parts, so as to minimize the restrictions on the activities of rescue personnel; The anti-collision part of the elbow is designed with a 3D wrapped shape and split lines, which maximizes the protection of the elbow joint while ensuring the flexibility of the arm movement.

#### 4.4 Structure and form design of rescue tool

Through analysis, it is found that the most fluent movement trend is that the arm first drives the hand in the horizontal direction for a distance and then turns to the forward

circle. Therefore, the actions of rescuers using this rescue tool are as follows: Hold the left and right parts of the device in your hands and slide them out, then wrap your hands around the device from behind the person, and finally connect the top of the left and right parts in front of the person. Because the human palm is affected by the two muscle groups and finger length, it is almost like a round table when it is held, so the basic shape of the rescue tool is cylindrical. At the same time, in order to increase the connection probability, the connection end of the two parts adopts the design of hemispherical. Figure 2 shows the steps for using the rescue tool

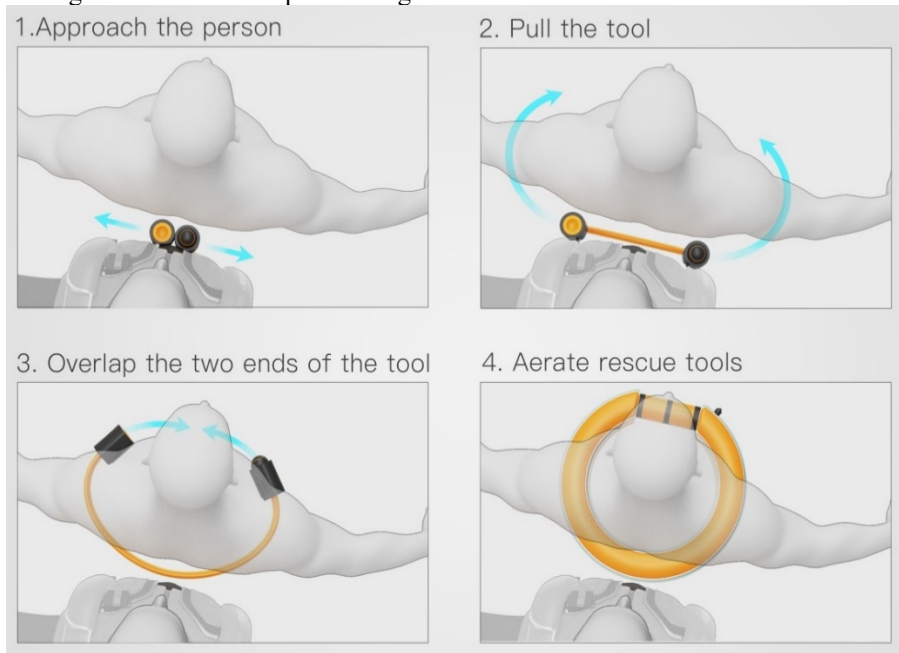


Fig. 2. Rescue tool use flowchart

#### 4.5 Structure and form design of life whistle

The life whistle is attached to the life jacket by a magnetic suction component. The magnetic suction component has a wheel shaft inside, and the rope connected to the life-saving whistle can automatically shrink through the wheel shaft, and drive the whistle to adsorb on the component [10]. The contact surface between the magnetic suction part and the whistle is flat, so that the whistle can be more firmly adsorbed on the magnetic suction part.

## 5 Conclusion

Aiming at the target users of water special life jacket, the AEIOU method is used to analyze their behavior in the process of water rescue, and the user behavior model is

built, which points out the direction for the design. After determining the core function of the product, the key technology principle, product structure and form were studied, and finally the design of the water special life jacket was completed. On the premise of ensuring the safety of rescuers, this life jacket can effectively assist rescue and improve the success rate of rescue.

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