



## AEIOU Analysis on Tools Design Requirement for Visually Impaired

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### Abstract

By utilising the AEIOU method, the user behaviour observation of the analysis framework and the behavioural pain points of the visually impaired in the vegetable-cutting process were deduced. This study aims to assist visually impaired users in completing their kitchen activities, avoiding accidents, and improving the experience of simple operation and safer use while intending to create a comfortable kitchen environment and supplement the extended application of visually impaired products. The newer analysis was intended to facilitate the conversion of research, sorting, and study results into design practice in producing future research in a related area.

Keywords: AEIOU Analysis, Visually Impaired, Tools Design

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### 1.0 Introduction

According to the 2016 national survey of people with visual disabilities, the number of people with visual disabilities is about 17 million, with an annual increase of about 450000 (Qiao, Xu, Ding, & Chen, 2022). The figure is enormous and growing. The public's attention and assistance to the visually impaired are represented in medical rehabilitation and day-to-day assistance (H.Liu et al., 2021; Jabbar, Lee, & Cho, 2021). In everyday life, visually impaired people dread and lack safety protection in the kitchen, and handling food products has become difficult and dangerous. Currently, visually impaired people's functional and psychological needs still need to be fully considered in kitchen tools, specifically knives, in the market. Accidents are common while using standard kitchen blades, and the action of loading veggies when cutting vegetables increases their cognitive burden. As a result, visually impaired persons hope to be able to obtain security guarantees to improve their independence and support the development of additional items for visually impaired people (Wang, Zheng, & Fan, 2017).

Regarding kitchen space layout, there have been changes in the kitchen layout of people with disabilities in the context of household appliance fashion trends. Heidi, a German company, optimises user experience regarding operational comfort and functional layout. In the early 21st century, it proposed the kitchen concept, summarised as shortening the operational distance, optimising operational processes, clarifying functional planning, and rationalising spatial layout. In exceptional support for disability actions, it should also explore reasonable spatial planning for it.

### 2.0 The theoretical framework of AEIOU user research

AEIOU is an experimental, analytical method for interpreting observation founded by Robinson et al. in 1994. It was initially used to analyse data and build models to solve problems (Hanington & Martin, 2019). The AEIOU framework includes five aspects: activity,

environment, interaction, object, and user (as shown in Figure 1). The researcher observes the Respondent's daily activity according to five aspects, then sorts out analyses and summarises the collected user behaviour information (Palani, Fink, & Giudice, 2022). Users' activities and actions to achieve their goals are called activities. The location and spatial structure of activities are referred to as the environment. The interactive information between persons or products is referred to as interactive information. Objects are objects utilised by individuals in the course of carrying out activities. These objects are classified as primary and secondary, focusing on the primary objects. The user is the person performing the activity and must have a thorough understanding of the subject of the activity, including the subject's hobbies, income status, nature of work, needs, and others.



Fig. 1: AEIOU user framework  
(Source: (Hanington & Martin, 2019))

### 2.1 User research: characteristic analysis

Psychologist Treicher pointed out that approximately 83% of human information comes from visual perception, and external stimuli can quickly impact human psychology. Blind people's lack of visual perception leads to a significant reduction in external stimuli. Compared to non-disabled individuals, blind individuals are prone to feeling uneasy and nervous in the external environment, lacking a sense of security. Only through long-term exploration of the environment and products, targeted training, and enhancing familiarity with the environment, products, and people can blind individuals significantly reduce their sense of insecurity and tension.

The behaviour is unpredictable. When humans want to perform a specific behaviour, they will usually take a tentative action, use their hands, feet, or some other part of their body to sense the direction or object information, and investigate whether it is safe within the range of the forward direction and whether there is a potential safety hazard. Only once it has been determined that there is no threat can it be moved forward or implemented. Establish a routine for positioning objects. They will replace the things after taking them. They will replace the water cup when they have used it. The researcher discovered from the Respondent that this behaviour is to avoid forgetting the item's location when taking it the next time. The pace with which information is received through touch is slow and one-sided.

First and foremost, the product information provided to the user is the product surface texture information, followed by an exploration of the product's function. According to the research on the tactile experience of visually impaired individuals, this study establishes a connection between human tactile sensation and design elements such as product function, shape, usage, and materials. It proposes a tactile sensory design concept as a guide (Hu Xinming, 2016). Zeng Dong (2020) proposed to start from the perspective of human psychology, behaviour, and materials and summarised the research on expectations and materials for tactile experiences in recent years. Such as the product's prompt should be simple and concise. Few persons have had braille education at school and can read braille. Visually impaired people's goods prefer to deliver information through the tactile perception of concave and convex graphics or auditory sense. For example, bright product touch screens or keys convey information (Patel, Etminani-Ghasrodashti, Kermanshachi, Rosenberger, & Weinreich, 2021).

## 3.0 Methodology

### 3.1 Demand survey

The research object of this paper is determined to be a respondent for the visually impaired to make the user demand survey more realistic and universal. Twenty-four visually challenged people were chosen for interview, observation, and recording with the president of the Disabled People's Association in Wuhu, Anhui Province. Researchers have learned that these 24 visually impaired individuals must use kitchen tools and have a desire to cook independently. The interview and observation focused on visually impaired people's behaviour when using kitchen knives, loading behaviour, and employing psychology, and retrieved reference bases for their functional and psychological demands. There is congenital blindness and acquired blindness among these 24 visually challenged adults, as well as disparities in behavioural and cognitive ability. According to statistics from interviews with 24 visually impaired people, 16 visually impaired people occasionally use kitchen knives for cooking, four never use them, four need to use them every day, and 20 visually impaired people hope to use kitchen knives safely to achieve their desire to cook independently (as shown in Table 1).

Table 1. Investigation on the use of kitchen knives

Intend activity	Total respondents
Occasional use	16
Never use	4
Daily use	4
Want to use	20

(Source: Author)

### 3.2 Create user profile

As a typical study object, the researcher chose one Respondent, Respondent A. This typical user's partner is also a visually impaired person who runs a massage parlour at home and needs to cook almost every day. Living with their parents, as their age increases, typical user couples also need to undertake more family activities and receive more supportive assistance to complete. These characteristics meet the requirements of typical users. The researcher did extensive research on it in conjunction with literature and research, eventually sorting out data with typical user characteristics (as shown in Table 2).

Table 2. Respondent background

Items	Detail
Typical user	Respondent A
Visual status	acquired total blindness
Gender	Female
Occupation	blind masseur
Marital status	married
Age	45
Education background	Junior High School
Aetiology	blindness due to later congenital disease. In the beginning, the vision of one eye is blurred, and later, both eyes are blind
Living status	living with family, a family of three, two rooms, one living room, one kitchen and one bathroom
Previous job	cook assistant, housewife
Working time	5 years
Working hours	set up a massage shop for the blind at home, work at 9:00 am., and work intermittently or continuously until 11:00 pm
Family members	husband and son, a family of three
Personality description	cheerful and sensitive
Salary	approximately 50000 yuan per year
Diet	do it by herself: Three or four meals a day, usually porridge for breakfast, rice for lunch and dinner, and noodles occasionally. If she works late at night, she has to eat a night snack. Night snack usually consists of slim, dumplings, wonton and other fast food

(Source: Author)

## 4.0 Findings

### 4.1 Kitchen layout and action track analysis

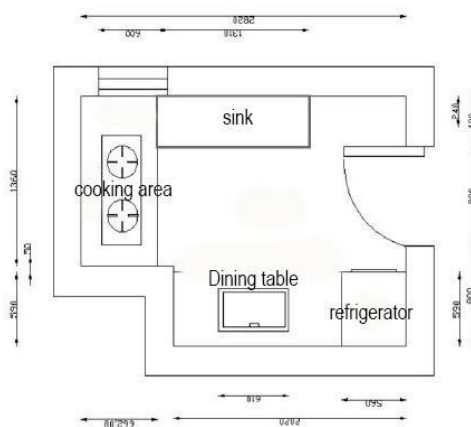


Fig. 2: Typical user's kitchen layout

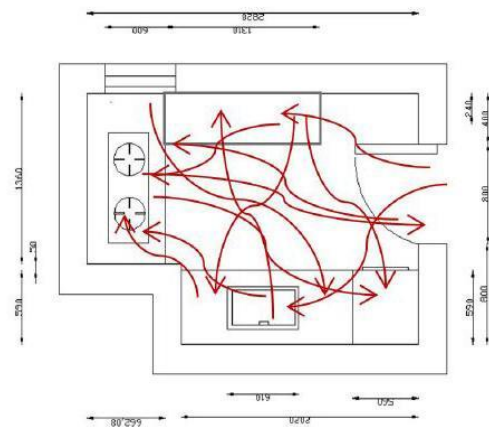


Fig. 3: Respondent A kitchen activity track

(Source: Author)

Respondent A is a three-person family who lives in a two-room, one-room, one-kitchen, and one-bathroom apartment. The total area of the house is approximately 86 m<sup>2</sup>. The kitchen is relatively modest and compact, measuring only around 4 m<sup>2</sup>. The activity area is relatively small and can only fit her activities in the kitchen. The kitchen has a U-shaped arrangement (see Figure 2). The refrigerator is on the left side of the kitchen entrance, while the sink is on the right side (the operation area for Respondent A to clean and cut food materials). The width of the operation table is around 50 cm, and the height is approximately 80 cm. Above the space for sorting and cleaning food materials is a section for auxiliary materials (ginger, garlic, and scallions). The lower part of the sink console acts as a storage area for food and containers, and the garbage can is located in this area, making it easy for Respondent A to dispose of waste food. The cooking area is located in the centre of the kitchen, with the condiments on the upper right side of the stove. The other parallel side of the operation area has a table with a width of approximately 24 cm and a height of approximately 86 cm. Respondent A must go back and forth between the kitchen sink and the placement table while taking and placing food ingredients, which increases her

behavioural contact point. Lettuce and vegetables are typically placed on the table, making it easy to need clarification when taking them, adding to Respondent A's memory burden.

Furthermore, the cooking area is in the centre of the kitchen, with the condiments on the upper right side of the stove. The stove's design is both absurd and unsafe. It is next to a window, which can easily catch fire. The figure below depicts the respondent chronology of kitchen activities (Figure 3).

#### 4.2 Behavior analysis of using kitchen knives

The researcher observed Respondent A's kitchen activities and behaviours in a non-participatory manner, focusing on her use of kitchen knives, and conducted in-depth interviews to fully understand the behaviours closely related to the use of kitchen knives, as well as making detailed records from the three aspects of taking, using, and cleaning kitchen knives. Respondent A served her favourite dish, braised eggplant, in brown sauce. The examples below demonstrate Respondent A thorough kitchen operation. Respondent A tentatively gripped the cutting board and knife handle while utilising a knife on the operating table near the washing area. The kitchen knife was an average knife. The cutting board is positioned vertically, near the refrigerator and the wall. The blade is flat beside the cutting board, with the blade towards the wall. The cutting board and blade to the right are then removed and placed in the water tank. After washing, turn the cutting board to the left and lay the blade flat outward to avoid cutting her hands again (see Fig. 4).

Respondent A used a kitchen knife to remove the eggplant from the basket before the cutting board and place it on it. With her right hand on the blade and left hand on the eggplant, she uses the blade body to determine the eggplant's direction. She then touches the edge of the eggplant to determine the position, lifts the blade to the surface of the eggplant skin, moves the left hand to the right to touch the blade body, and measures the middle of the eggplant with the left-handed finger. The fingertip is close to the blade body and cuts off the middle and back sections of the blade. When cutting the eggplant, she used her fingertips to judge its thickness and then sliced it off. Respondent A must repeat this procedure to cut the eggplant. After chopping the eggplant, she picked it up with a knife and placed it in the sink basket. She placed the basket on the rear placement table after loading it (as shown in Fig. 4 and 5). When loading the veggies into the dish, it is easy to leave the veggies on the operation table or cutting board. When placed, it is easy to combine it with other ingredients and cooked vegetables, and it is easy to be scalded by cooked vegetables when it is felt by hand. The cutting space is only sufficient to accommodate a chopping board and cannot retain the prepared materials.



Fig. 4: Behavior of eggplant cutting with knife

(Source: Author)



Fig. 5: Put vegetables into the basket

When cleaning kitchen knives, she uses her right hand to determine the position of the cutting board, then feels the handle of the blade, takes it to the sink with it, wipes the blade with a rag, cleans the blade from top to bottom with a rag from the back of the blade, and then uses her hand to determine whether the blade is clean and replaces it, and cleans the cutting board (as shown in Figure 6).



Fig. 6: Respondent behavior of eggplant cutting with knife

(Source: Author)

#### 4.3 Construction of User Behavior Analysis Model

Reorganise, classify and thoroughly analyse the observation data collected using the AEIOU framework to identify the user's behavioural pain points, determine the meaning and purpose of the activity, deduce the reason for the user's behaviour, and thoroughly analyse the

data to extract the same path or common goal. According to the AEIOU framework, the following is to record the usual user's kitchen space layout and interaction with kitchen supplies and sort out Respondent A's interaction with food materials (Table 3).

Table 3. Activity record based on AEIOU framework

Framework	Activity
<b>A</b>	1. Take and place kitchen knives 2. Fix the position of kitchen board and kitchen knife 3. Feel the size and thickness of food with her fingers 4. Clean kitchen knives with a rag 5. Touch the blade to determine whether it is clean 6. Copy the vegetables with a knife and put them on the plate
<b>E</b>	Kitchen space: Common use by family members, limited, unsuitable for one person to take objects in a U-shaped layout pattern. The loading area is disorganized, food is frequently left on the chopping board and operation table, and the rubbish can is being searched for.
<b>I</b>	1. Fixed anvil position 2. Using kitchen knives to cut vegetables, tactile perception of food information 3. Clean kitchen knives with a rag Touch the blade with her hand
<b>O</b>	Main kitchen supplies: Kitchen knives, cutting boards, garbage cans Secondary kitchen supplies: a dishcloth, a veggie basket, and a sink
<b>U</b>	Respondent A

#### 4.3 Behavior pain point and purpose analysis

The AEIOU technique is the rearrangement, classification, and extensive analysis of observation information recorded within the AEIOU framework to determine the meaning and purpose of the action. It is deducing why visually impaired individuals have this behaviour, thoroughly analysing and recording facts to extract the same path or shared aim, and summarising the purpose of visually impaired people's culinary activities. The following is based on the behavioural characteristics of visually impaired users using kitchen knives, the framework analysis of the interaction between the environment and kitchen knives, and the behavioural pain points of the kitchen in handling food materials to investigate the purpose of the activity and the deep needs of visually impaired users (Table 4). The AEIOU framework for processing food materials is examined through Respondent A's record, the goal of processing food materials is determined, and the analysis points are focused on the items, making it easier to integrate the outcomes of research, sorting, and analysis into design practice.

Table 4. Analysis of behavioral pain points and purposes

	Pain point analysis	Purposes
Use kitchen knives	1. When picking up kitchen knives, the handle is easy to be scratched by the blade and it is difficult to identify the position 2. It is difficult to judge the size and thickness of the cut vegetables during the cutting process, and it often cuts the nails and fingers 3. Feel whether the blade is clean and easy to be injured by kitchen knives	Safe cutting, cleaning and taking kitchen knives, judging the size and thickness of food materials, easy to install
Kitchen layout	The chopping area is too small to accommodate the next chopping boards. Respondent A tends to forget where the ingredients she put and when she wants to take it back and forth from the operating table and the placement table. Respondent A need to clean her hands again when she looks for it, which increases the user's memory burden. In addition, the retrieval from outside also increases the activity route of users with visual impairment	Simplify the action route, clearly distinguish the functions, and make the operation process clear

(Source: Author)

## 5.0 Strategy design based on AEIOU-P framework

### 5.1 Strategy design based on AEIOU-P framework: Spatial layout transformation

The kitchen space layout is modified based on visually impaired users' kitchen operation behaviour characteristics. The layout that complies with Respondent A behaviour process is examined to satisfy the functional zoning of its operation process, achieving clear functional zoning, smoothing the operation process, simplifying the activity route of visually impaired users, and facilitating the operation of visually impaired users. To shorten and identify the activation pathways of visually impaired individuals. The following transformation diagram of the kitchen design plan proposed for Respondent A is shown below to reduce the design of multiple contacts and the memory points of users with visual impairment (see Figure 7).

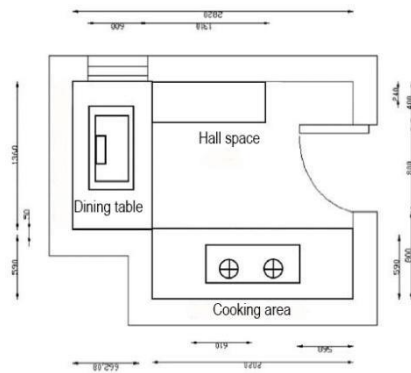


Fig. 7: Reconstruction design of kitchen space layout for the visually impaired  
(Source: Author)

### 5.2 Design of auxiliary tools for kitchen knives

The design of the kitchen knife should meet the requirements of convenient operation, transparent information transmission mode, and reduction based on the need of the visually impaired for the blade knife, that is safe usage. The kitchen knives' design should prioritise product safety to avoid mishaps when using kitchen knives.

### 5.3 Tool auxiliary tools on structure

The kitchen knife's design is based on the notion of safe use. Safety is the foundation of all activities and behaviours, and the goal is to keep the visually impaired from cutting their fingers when utilising. Fingers can rapidly and dexterously discern the thickness of food ingredients, providing a sense of security to the vision impaired.

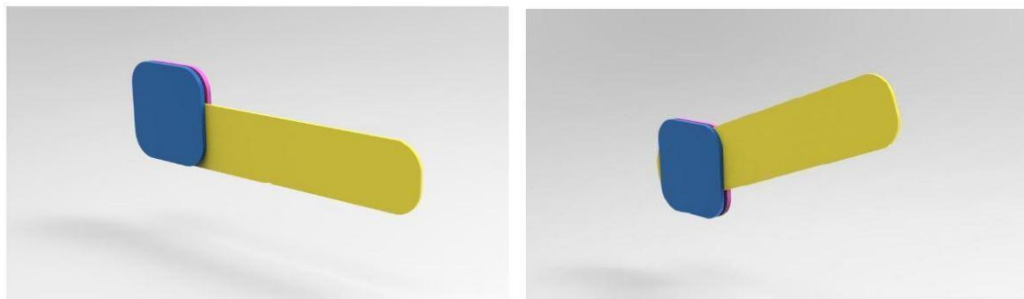


Fig. 8: Design diagram of kitchen knife for impaired  
(Source: Author)

An auxiliary mechanism is placed on the blade to protect the kitchen knife from cutting fingers. It is also appropriate for all sizes of kitchen knives, making it easier for the visually impaired to cut food. The kitchen knife's stationary position is the same as the blade's (Fig. 8). The use position of the kitchen knife and auxiliary equipment will float up and down with the thickness of the material, allowing it to cut materials of various thicknesses (Figure 8). The auxiliary equipment can also be mounted to the back of the kitchen knife and placed according to their attitudes and behaviours. The kitchen knife's auxiliary equipment features a built-in magnet, making it easy for particular users to take any position on the kitchen knife body. Separate the blade from the finger when cutting food to reduce contact between fingers and the blade. According to the thickness of the cutting material, the auxiliary equipment will also separate the food from the blade. This kitchen knife auxiliary equipment has a simple design and is simple to clean. The technique used is the same as regular people's, reducing their disparity. During installation, additional tool support can be rotated by 90 degrees first, close to the blade, and then slid vertically to the blade. The procedure is straightforward.

### 5.4 User experience of tool auxiliary tools

The cutting tool's auxiliary tool is composed of plastic, which is effective, antibacterial, safe, and meets the food contact requirement. It is antimicrobial and stops bacteria from breeding. The surface texture is rough and can convey a close and warm touch. The roughness of avoiding direct contact with metal imparts a cold and threatening feeling. The auxiliary tool has a simple structure and is easy to disassemble, clean, and install. When in use, it can be installed directly. The operation is straightforward, and the user can do it on his or her own. It lessens the memory strain on consumers during the use and complicated operating process.

## 6.0 Conclusion and Recommendations



The visually impaired population heavily relies on tactile sensory references for spatial judgment, which can easily lead to kitchen accidents. However, existing solutions in the market are often function-centric and rarely focus on usability. Their behaviour is formed through targeted training, and usually, they need to become more familiar with the purpose of the product. Therefore, it is necessary to use physical, tactile cues, which can be relied upon in the next step of the cooking process (Vermol. V.V., et al., 2022). In addition, in design practice, exploring what graphics can help visually impaired people quickly obtain information is also a question that needs to be considered in future research. On the other hand, utilising other senses of visually impaired individuals, such as hearing and smell, fully mobilises the senses of blind individuals to obtain product information, develop multiple senses to transmit information through interactive behaviour, and eliminate the use barriers of blind users.

Focusing on user behaviour study, explore the interacting behaviour characteristics and perceptual ways between blind users and products, as well as the functional usability, usability, and emotional experience needs of blind users for the blade tool (Wang et al., 2017). Finally, the tool's design is complete, and its theory is applicable. In a gender and shape test, it was discovered that there is an implicit link between product shape and gender (Lujie, Lizhu, & Jiang, 2022). This finding is supported by a study that proves that male consumers prefer angular forms, whereas female consumers prefer circular shapes (Ying, Jun, & Yansu, 2019). Hopefully, this study will gain a fundamental approach to considering space layouts for the impaired that a kitchen and interior designer can refer to in producing and proposing a layout for the unique needs of the impaired.

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## Paper Contribution to Related Field of Study

This article contributes to the field of study in the area of Design for Disabilities and User Behavioral space design.

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