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Innovative Design of Multifunctional Air Conditioning Products Based on Art Design

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Abstract: Innovative design is used in this study to solve the issues of high idle rates and excessive occupancy of air conditioning goods. It starts with the demands of the users. The study focuses on user needs, first gathering those needs through user conversations and questionnaire surveys along with generating user role models, then mapping the user experience journey to investigate design opportunity points, and finally developing an innovative design solution for a multifunctional air conditioning product centered on those needs in accordance with the design opportunity points. The design solution incorporates intelligent components that can deploy temperature, humidity, and air purity information intelligently to give consumers a more pleasurable indoor air management experience. The method addresses the issue of a high idle rate while also taking up less room and maximizing the utilization of interior space.

1. Introduction

The need for high-quality indoor air is increasing as people's living standards rise. A/C smart home goods, including air conditioners, air purifiers, humidifiers, and dehumidifiers, are now considered essential household appliances [1]. However, because these items are independent of one another, customers must buy more than one to satisfy all of their indoor air quality needs. Families are put under more financial strain, and this takes up room within. This research offers a novel, "user-centered" design for air conditioning goods to address the aforementioned issues [2].

2. User requirements analysis methods and the design process

User needs, which comprise the features, functionality, and experience that consumers anticipate when using a product, are at the heart of product design [3]. We must satisfy consumers' demands, as well as thrill and surprise them, in order to provide a positive user experience [4]. In addition to serving as a design's starting point, user needs also serve as its ultimate objective. There are two types of wants that may be distinguished: explicit needs and implicit needs. Users' needs, such as those related to product features, functions, etc., are referred to as explicit needs. Implicit needs, such as those related to product safety, emotion, etc., are demands that a user has but does not express explicitly [5]. Because different degrees of requirements influence people's behavior, we must start with those of the user in order to develop a solution that will more effectively satisfy their needs and provide value [6].

In this paper, users were examined qualitatively and quantitatively by means of user interviews and questionnaires. By building user portraits and user journey maps, user portrait requirements and design opportunity areas are identified. Combined with the design opportunity points to generate the product solution, the full design process is represented in Figure 1.

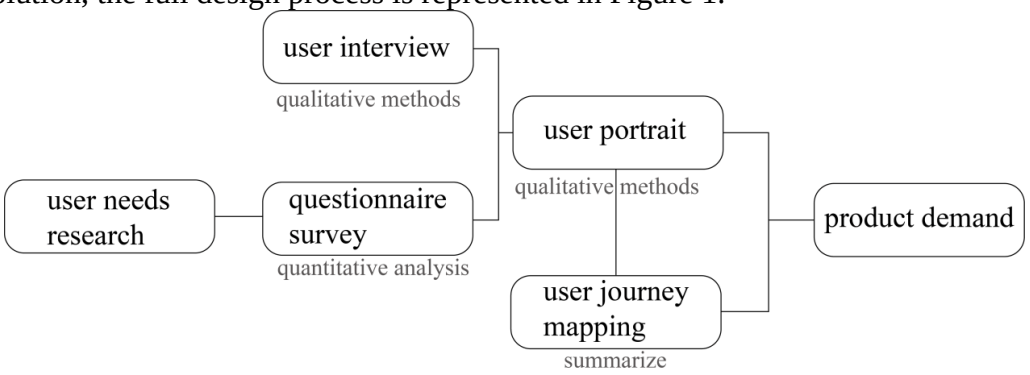

Figure 1: User requirements-based design flow

(1) A user interview is a means to understand the needs, expectations, and usage habits of potential or present users through face-to-face discussion with them. In product design, user interviews are a qualitative research method that serves to collect user needs, identify user personas, and discover problems and opportunity points, which can help to gain a deeper understanding of user needs and usage scenarios and provide valuable ideas and directions for product design.

(2)The questionnaire method is a regularly used quantitative research method that collects trustworthy data through controlled measurements, and the weight and proportion of the data may be examined by quantitative analysis. Questionnaires can be distributed in a variety of ways, including online applets, offline individual distribution, group distribution, and mailing. The questionnaire analysis can obtain first-hand, authentic data [7].

(3) User profiling as an information analysis technique [8] User profiles can be used to visualize user demands [9] and to build products that better satisfy user expectations. User profiles normally comprise basic information about the user's needs, preferences, pain areas, and goals. By gathering and analyzing data from target users, people can be classified into multiple groups based on different characteristics and criteria, and a representative user persona can be developed for each group.

(4) A user journey diagram is a graphical tool used to explain the process of user interaction with a product or service. It is frequently displayed in the form of a diagram or flowchart to help product teams and designers better understand the user's experience and demands throughout the usage process. User journey diagrams include the essential activities, feelings, and expectations of users at each stage of utilizing a product or service. It can help teams uncover consumer pain spots, needs, and opportunities to improve product design, optimize the user experience, and raise user satisfaction [10].

3. Multifunctional air conditioning products require research and analysis.

3.1 Content and analysis of user interviews

The user interview mainly includes the following contents: to understand the current air conditioning products used by households; to comprehend the idle situation and disposal of existing air conditioning products in households; and to examine the expectations and needs of households on the design of the air conditioning product portfolio.

Before conducting the interviews, 10 eligible respondents were screened by posting recruitment information, and the interviews were conducted using semi-structured interviews, in which structured

questions covered the current situation, problems, and treatment of existing product use, and unstructured questions included suggestions and expectations of existing product use. The findings of the interviews (Figure 2) showed that air conditioners, fans, humidifiers, dehumidifiers, and air purifiers were the most widely used types of air conditioning products. However, these goods suffer from a high idle rate, a huge footprint, a non-visible working process, a lack of feedback on engagement, and cumbersome cleaning. According to user feedback, the functions of present air conditioning goods are generally independent, frequently necessitating the use of numerous products to meet their respective difficulties, such as humidifiers to alleviate the problem of dryness created by air conditioning. In addition, according to the interviews, users' needs for air conditioning products are diversified, and respondents wish to have integrated product options.

numerical order	existing air conditioning products	existing problem	ways of resolution	design suggestion
1	air conditioner, electric fan, humidifier	Low frequency of use, occupy space; Air conditioning feels dry when used; Dehumidifiers need to be placed in each room and take up space.	Use a humidifier while using the air conditioner.	Intelligent, energy saving
2	air conditioner, electric fan, dehumidifier	Air conditioning feels dry when used; The dehumidifier needs to be placed in each room and covers a large area.	Keep a basin of water indoors.	Save space, easy to clean
3	air conditioner	Air conditioning feels dry when used; Hard to clean.	Keep a basin of water indoors.	Easy to clean
4	air conditioner, electric fan, humidifier	Air conditioning remote control can not be found; Air conditioning and heating feel dry when use.	Use a humidifier while using the air conditioner.	Intelligent, APP operation
5	air conditioner, electric fan, humidifier	Humidifiers need to be placed in each room, covering a large area.	Put it away when not in use.	Energy conservation
6	air conditioner, electric fan	Low frequency of use, occupy an area;Hard to clean.	Put it away when not in use; Find master door to door cleaning.	Set cleaning reminders
7	air conditioner, electric fandehumidifier, air purifier	The dehumidifier needs to be placed in each room and covers a large area.	Put it away when not in use.	The function is not complicated; Simple operation; Work feedback
8	air conditioner, humidifier	Humidifiers need to be placed in each room, covering a large area.	Put it away when not in use.	Simple operation
9	air conditioner, humidifier, air purifier	Humidifier needs to be placed in each room, covers an area of large air purifier needs to be placed in each room, covers anarea; The air conditioner feels dry when used.	Put it away when not in use.	Intelligent, set cleaning reminder; Work feedback
10	air conditioner, humidifier	Air conditioning feels dry when used; Humidifiers need to be placed in each room, covering a large area.	Put it away when not in use.	Easy to clean

Figure 2: User interview results

3.2 Questionnaire content and analysis

In order to have a greater understanding of the present status of the usage of various types of air conditioning goods and user needs, a questionnaire survey was utilized to quantify and assess the use, idle state, and disposal of existing air conditioning products. A total of 263 questionnaires were submitted, and a total of 263 valid questionnaires were returned, with an effective recovery rate of 100%. The questionnaires were put in 34 provincial administrative regions across the country, with the Qinling and Huaihe Rivers as the dividing lines, with 200 copies of data in the south and 63 copies in the north, and the following conclusions were derived based on the questionnaire data:

(1) Use of air conditioning products: Among the questioned households, air conditioners and fans were the most commonly used air conditioning products, accounting for 84.03% and 75.29%, respectively. The utilization rate of humidifiers and air purifiers is relatively low, accounting for 23.95%, 14.83%, and 11.03%, respectively. The use of air conditioning products is depicted in Figure 3.

(2) Number of air conditioning products owned: 52.49% of the 221 visits had 3 or more air conditioners in their houses, 23.08% had 2 air conditioners in their homes, and 24.42% had just 1 air conditioner in their homes. In the 29 visits, 75% of the residences had 1 dehumidifier, 17.24% had 2 dehumidifiers, and 6.9% had 3 or more dehumidifiers. 63 visits later, 77.78% of the homes had 1 humidifier, 17.46 had 2 humidifiers, and 4.76% had 3 or more humidifiers or dehumidifiers. 63 visits later, 77.78% of homes owned 1 humidifier, 17.46 owned 2 humidifiers, and 4.76% owned 3 or more humidifiers. 39 visits later, 87.18% of families possessed 1 air purifier, 7.69% owned 2 air purifiers, and 5.13% owned 3 or more. Air conditioning products are depicted in Figure 3.

(3) Frequency of utilizing air conditioning products: 42.08% of homes use air conditioners between 60 and 120 days per year, while 11.76% of households use air conditioners more than 180 days per year. 62.07% of households use dehumidifiers around 60 days per year, and 24.14% of households use dehumidifiers around 60–120 days per year. 58.73% of homes use humidifiers around 60 days per year, and 15.87% of households use humidifiers around 60 days per year. Humidifiers for around 60 days per year, and 15.87% of the households use humidifiers for roughly 60–120 days per year. 56.41% of the households use air purifiers for about 60 days per year, while 17.95% of the respondents use them for between 60 and 120 days per year. The frequency of air conditioning items is indicated in Figure 3.

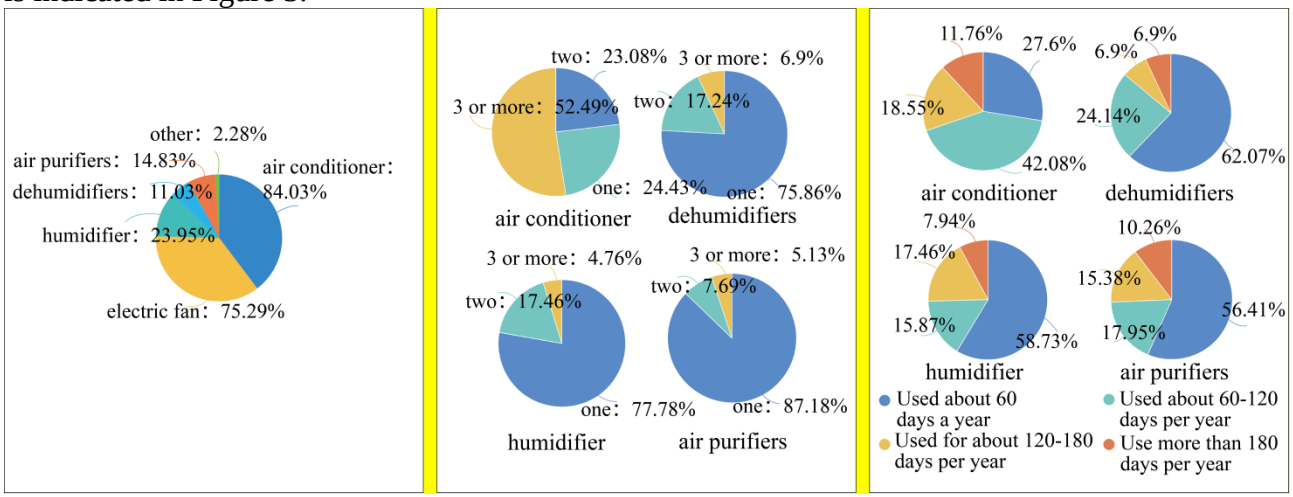

Figure 3: Air conditioning product categories, quantity, and frequency of use

(4) Concerns of air conditioner use: long-term continuous use will make you worry about health concerns; halting use will make you feel hot or cold; its comprehensive score is 5.57. followed by the

usage of the space air humidity is low (dry), its comprehensive score is 4.29, where the proportion of the first place is the most high, accounting for 67.57%, and the problem of air conditioner use is displayed in Figure 4 (a).

(5) Treatment of low air humidity (dryness) when air conditioners are in operation: 52.68% of households would set a pot of water in the room, 23.21% would use a humidifier, 16.96% would choose to open a window or open a door to change the air, and 4.46% would use an electric fan. The management of low air humidity (dryness) when air conditioners are in use is indicated in Figure 4 (b).

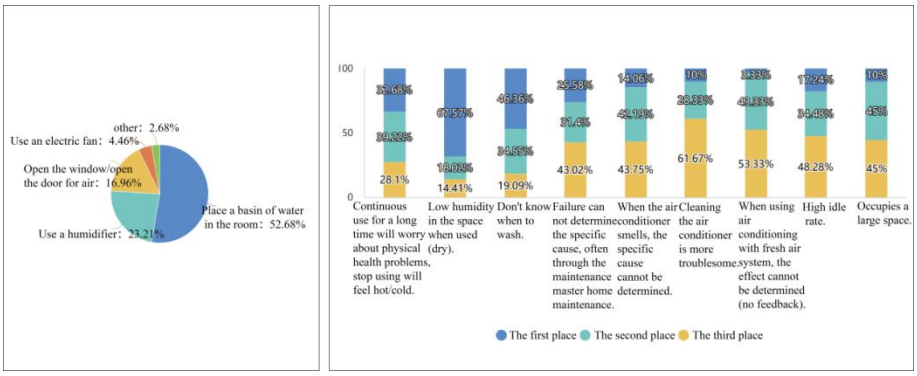

Figure 4: (a) Problems with the Use of Air Conditioners; (b) Handling of low air humidity (dryness) during the use of air conditioners

3.3 Persona

Creating a standard user profile. In order to link user needs with product design, we divide users into groups, design and test products based on different characteristics, avoid the problems designed, and facilitate accurate and quick analysis of the behavior and habits of the primary users of air conditioning products. The analysis results of user interviews and questionnaires are used to derive the corresponding user labels and create typical user profiles of the products. Comfort, health, energy efficiency, air purification, and improvement of the indoor environment are the primary needs of typical target users of air conditioning products. The use scenario is the family's indoor space, and usage habits center on the humidification effect, regular cleaning, and regular filter replacement, among other things. Figure 5 depicts the user portrait.

South China. Air conditioning product users
BASIC INFORMATION Ms. Chen Age: 36 Occupation: Accounting Education: Bachelor degree
Reasons to use the product When the weather is cold and hot, use air conditioning for cooling and heating; The south is humid, and dehumidifiers will be used to dehumidify.
Problems encountered Can not get work feedback when using, easy to forget to close the product; They can only be put away when they are idle and taken out when theyare in use. It is not clearwhen the air conditioner should be cleaned.
Self description 1. The intelligent vertical air conditioner used at home, sometimes when you want to operate the air conditioner in the kitchen, the mobile phone is not on the side, and you need to approach the operation far from the air conditioner. 2. Opened the air conditioning for a while, did not get cool, do not know what is the reason, think it may be needed to add fluorine, called the maintenance master to the door, but once the air conditioning really has a problem, the master door I know. 3. When I use the dehumidification mode, I don't know whether it is useful in the end, and the dehumidification mode will also cool, sometimes a little cold. 4. Sometimes I forget to turn off the air conditioner when I go out. I am too busy, even if my mobile phone can be operated, I forget it.

North China. Air conditioning product users
BASIC INFORMATION Mr. Liu Age: 28 Occupation: Designer Education: Bachelor degree
Reasons to use the product When the weather is cold and hot, use air conditioning for cooling and heating; Northern heating is too dry, will use a humidifier to humidify.
Problems encountered Can't find the remote control; Summer night timing and sleep patterns will be awakened by the heat and need to readjust the temperature; It is not possible to identify the specific component of the air conditioner failure; It is not clear when the air conditioner needs to be cleaned.
Self description 1. This summer for the first time to open the air conditioning, looking for a long time air conditioning remote control, after finding it also found that it has no electricity. 2. The north uses heating in winter, but the heating is too dry, it will open a humidifier, and each room needs to put one, which occupies a lot of space. 3. I am afraid that the air conditioner will be cold all night in summer, so I have to open a timer first,but sometimes I will wake up by the heat and get up in the middle of the night to find the remote control and then open it. 4. Sometimes eating hot pot at home, turning on the air conditioning, the taste inside the room will take a long time to disperse.

Figure 5: Persona

3.4 User Journey Map

Examine the contact points. Pain and opportunity points utilise user research techniques such as pre-interview notes and questionnaires. We identify valid user needs based on user pictures and user journey maps. We consider whether further optimisation is possible at the highest emotional touch points. For the lowest emotional touch points, we look for solutions and opportunity areas for the design of multifunctional air conditioning products. As indicated in Figure 6, the user journey diagram led to the following opportunity points: When an air conditioner is running, the air in the room becomes dry; cooling and dehumidification cannot be separated; long-term continuous usage will be unhealthy; cleaning is difficult; the usage of humidifiers, dehumidifiers, and air purifiers is minimal; failure and taking up space cannot pinpoint the exact cause.

	planning air conditioning	before use	in use	after use	other
purpose	1. It's a little hot today, open the air conditioning to cool down; 2. Turn on the air conditioner when the heating is not running.	1. Open the air conditioning to cool the heat; 2. Turn on the air conditioner to prevent cold.	1. Want to find a suitable temperature for me; 2. Change the mode.	1. Remind me to turn off the air conditioner; 2. Ventilation.	1. Sometimes do not know how the air conditioning cooling effect is not good; 2. The air conditioning fail-ure do not know the specific problem; 3. Do not know when to clean.
behavior	1. Today home feeling a little hot, open the fan does not work, open the bedroom air conditioning; 2. It's a little cold today. We haven't turned on the heating yet.	1. Found that the remote control is gone,had to open the living room vertical air conditioning, that can be opened on the control panel; 2. The remote control is out of power, but also go out to buy a battery back to open.	1. I am a little cold, turn the temperature up; 2. Blowing me a little hot, and a little stuffy, first close for a while; 3. There are many functions on the remote control,I do not know how to use; 4. My grandfather can not blow against the wind, can not blow for a long time, his physique is not good, there are basic diseases, it is easy to catch a cold, so we generally turn off the air conditioning at night, but sometimes it will be hot wake up, and then get up to open.	1. Something went out temporarily, for got to turn off the air conditioner, no one at home, the air conditioner blew for several hours; 2. Open for a long time uncomfortable, will turn off the air conditioning ventilation.	1. Once in the summer I opened the air conditioning for a long time, found that it did not refrigeration, do not know where the bad, we did not dare to dismantle, I called the master to repair, found that it is to add fluorine; 2. I open the air conditioning, its external machine suddenly made a lot of noise, I do not know what happened, had to close; 3. I just opened the air conditioning smelled a smell, do not know where it camefrom, had to call someone to wash.
contact	1. Power problem	1. Remote control	1. Temperature adjustment 2. Special population needs 3. Remote control	1. Turn off the air conditioner 2. Ventilation	1. Air conditioning inside and outside machine 2. Cleaning time 3. The specific problem of the failure
pain points and opportunity points	1. Different air conditioning power problems.	1. The remote control is lost and no power.	1. Feel too cold/hot before adjusting the temperature; 2. After the timing of the heat wake up also need to get up to open again.	1. Forget to turn off the air conditioning situation; 2. Ventilation.	1. The air conditioning failure do not know what is the reason; 2. Don't know when to clean the air conditioner.

Figure 6: User Journey Map

4. Air conditioning product design practices

4.1 Transformation of user requirements into product requirements

After establishing the user needs and the product needs, together with the aforementioned pain points and opportunity points, the preliminary research and analysis of user needs into product requirements will identify the precise functionalities of the product. Multi-functional air conditioning product demands are: (1) product installation position for simple cleaning; (2) space saving; (3) air purification function; (4) air humidity function; (5) air temperature function; (6) work process to offer feedback.

4.2 Concretization of product requirements

The conversion of product requirements into visual product design is known as product visualization (II). The functions and characteristics of the product should be chosen in accordance with the requirements. Visualizing product requirements does not imply that all requirements must be represented visually. To prevent building unnecessary product features, visualizing important, fundamental, and user-experience-related criteria should take precedence.

(1) In contrast to conventional wall-mounted air conditioners, which hang horizontally, multi-functional air conditioning products are shaped to fit 90 ° wall angles and can be hung vertically, making it convenient for users to fill the humidifier and replace the air purification filter. In addition, they are smaller and take up less space than conventional cabinet air conditioners, which require space for installation. Figure 7 depicts the installation location scene effect.

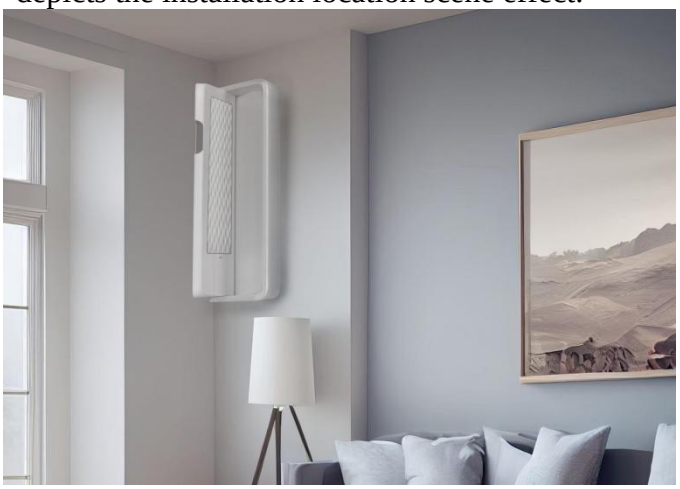

Figure 7: Installation Position Scene Effect

(2) Functions for air purification and humidity control: The air conditioner uses energy transfer and interior air inhalation to provide cooling and heating effects. Based on this, we installed a high-efficiency particle air filter at the air inlet, which can effectively shield the product's interior structure by filtering out microscopic particles. The filter is very simple to tune and disassemble. Advanced control techniques like intelligent control technology simulate intelligent human behavior to automatically regulate complicated systems. Fuzzy control, neural network control, genetic algorithm control, and other techniques are often used in intelligent control technologies. To obtain the optimum air cooling effect, intelligent control technology in air conditioning products may automatically modify the operating state of the goods based on changes in the interior environment that occur in real-time. For instance, an intelligent air conditioner will automatically change its mode of operation to lower the interior temperature when the temperature inside increases; an intelligent humidifier will automatically begin to raise the humidity inside when the air inside is dry. The mild adjustment module automatically opens while humidifying until the air humidity value meets the user-defined limits. Users can select the desired humidity value in advance using the air humidity adjustment feature. In order to provide consumers with the opportunity to change the humidity while preserving space, the air humidity adjustment module is retracted and closed when no modification is needed. The interaction between the air purification and humidity control modules is fair and easy to use. Figure 8 displays the air purification and air humidity module adjustments.

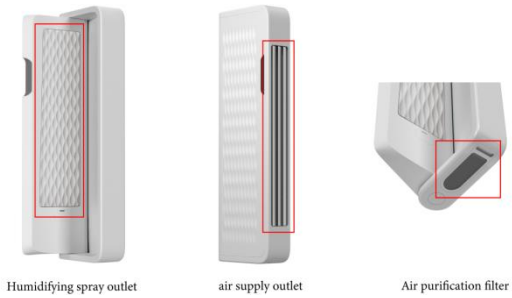

Figure 8: Air purification and air humidity regulation module

(3) Working method for providing feedback: the device has sensors to measure temperature, humidity, air quality, and the saturation level of the filter. The user receives real-time feedback via the mobile app.

5. Conclusion

In this study, we investigate a novel user-centered design approach for a multipurpose air conditioning device. To give a more comfortable indoor air management experience, the solution contains sophisticated capabilities that can automatically change the temperature, humidity, and purity of indoor air. The approach also addresses the issue of the high idle rate and occupancy of conventional air conditioning products while taking up minimal room and making better use of interior space. User experience journey mapping identifies design opportunity areas and offers direction for creative design.

The research techniques and design solutions presented in this work can serve as a model for the creation of air conditioning products and enhance the indoor air quality management experience for consumers. However, these goods could also be lacking in some areas. For instance, more upkeep and attention could be necessary to maintain maximum performance, and installation and maintenance might call for specific skills and knowledge—all of which are areas that could use greater study and development. The intelligence and user experience of the product may be enhanced in the future, and design solutions can be further refined to satisfy consumers' expanding demands.

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