FINAL EXAMINATION

SYMBIOSIS

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An emotionally designed humidifier based on dynamic design and behavior elicitation.

ABSTRACT

In this paper, I analyze the interaction and operation of humidifiers in the existing market and find the shortcomings in the user operation process. The main features are the programmatic and dogmatic way of conveying information about the humidifier, and the rigidity of the user's motivation and operating experience. After understanding these deficiencies, the authors tried to explore new ways of interaction to convey product usage information and to allow users to use the humidifier in an instinctive behavioral way, rather than following the humidity data and forcing them to use it. Therefore, the authors decided to adopt a dynamic product design approach to convey air humidity information, and tried to create some kind of product semantic symbols in this way to evoke the user's past knowledge or life experience, so that the user can switch from passively operating the product to following the instinctive and natural behavior, thereby enhancing the empathy between the user and the product, and guiding the user to use the humidifier continuously and gradually develop healthy living habits.

Contents

1. Subject Background

1.1 Pain Point Insights

The starting point of this paper is when users know they should use the humidifier, in other words, how users know whether the current humidity environment is healthy or not, and whether they should use the humidifier to adjust the indoor humidity. This is the initial motivation of the user to use the humidifier, but also the user can continue to have a good emotional experience of the key, and this emotional experience also determines whether the user can establish an attachment with the product, so that the user to develop healthy habits of use. For this area, I designed the key questions of the interview questionnaire and interviewed 50 users who have used the humidifier for at least a few months, the following are the most representative user responses.

Question Summary
Survey design
Q1: How often should I use it?
Q2: What motivated you to use a humidifier?
Q3: Has the use of the humidifier helped you form a healthy lifestyle?
Q4: Can the way you use the humidifier make you feel attached to it?

User 1

Name: James
Age: 25
Address: Milan

A1: To be honest I don't use it very often, maybe two or three days a week during the dry season.
A2: I have a hygrometer in my house, and when I see the needle of the hygrometer pointing at the dry area, I will think of starting the humidifier to adjust it.
A3: No, the humidifier is just sitting there when it's not in use, or I'll put it away if I don't use it for a long time.
A4: Because I usually do not need to use the humidifier, I bought it to seek a psychological comfort, so there is no attachment to the humidifier.

Image 1.
User 1

User 2

Name: Jenny
Age: 28
Address: Roma

A1: I use a humidifier four or five days a week during the dry season.
A2: Because I have rhinitis, I get very uncomfortable when the air is dry, so whenever I feel uncomfortable I go to start the humidifier to adjust the air humidity.
A3: I think I already have healthy habits, which I have developed myself, but I don't feel that the humidifier has helped me in this process, it's just a tool for healthy living.
A4: Because I have rhinitis, I am somewhat dependent on the humidifier, but if that is not the reason, I don't know.

Image 2.
User 2

Image 3.
User 3

User 3

Name: Alex
Age: 36
Address: Milan
A1: My humidifier is able to control constant humidity, so I keep it on during the winter, it is very time to adjust the air are decided by the humidifier itself, I do not care at all.
A2: I do not use the motivation, because it is completely automated, of course I can go to their own control whether it works, but I think if it can be adjusted autonomously, then I do not need to personally control it.
A3: I don't think so, because my humidifier can control the humidity autonomously and I'm not concerned about the air humidity level in the process.
A4: I think when the smart humidifier is working I have no attachment to it because its working process is completely automatic and I am not overly involved or emotionally invested in it, so there is no attachment to speak of.

Users usually learn about information and use humidifiers in three ways as next chart.

1.1.1 By Hygrometer

The use of a humidifier begins with a judgment of the suitability of the air in the room, and the most common way to determine whether the current air humidity is the optimum level is through a hygrometer. The operation process of this method is that the user through the independent hygrometer or attached to the humidifier itself above the hygrometer to make a preliminary judgment of the current humidity of the indoor environment, so as to determine whether the current air humidity is appropriate, if the air humidity is lower than the standard suitable for life, the user will take the initiative to turn on the humidifier to adjust after the judgment. Some hygrometers usually have three air humidity indication areas, representing dry air, suitable

Image 4.
Measuring air humidity with a hygrometer
https://unsplash.com/

humidity and humid air. The user's goal is to adjust the humidity level of the room to a comfortable zone through the humidifier.

Pain point analysis: this operation process is undoubtedly the most common and efficient. But on the other hand, the user can only passively and mechanically follow the instructions of the cold numbers, lacking their own initiative and spontaneity in the process. At the same time, the number or pointer as an artificial abstract

symbol is generally not easily perceived by people, so that the stereotypical way eventually easy to cause users to ignore the attention to air quality and gradually reduce the enthusiasm for the use of humidifiers.

1.1.2 Perception of Itself

For some cheap or single-function humidifiers, the humidifier is not equipped with a humidity sensor inside the humidifier, so it cannot convey the air humidity information to the user. In this case, if the user does not have a hygrometer at home, then the only way to judge the suitability of the air is through the user's own perception: when the user perceives obvious dryness and discomfort will turn on the humidifier adjustment. Pain point analysis: and this way is undoubtedly lagging, can not effectively adjust indoor humidity in a timely manner, and will also make the user of the humidifier use time into confusion, and eventually gradually lost the enthusiasm for the use of humidifiers, can not form a healthy habit of life.

Image 5.
Sensing humidity through the body
https://unsplash.com/

1.1.3 Humidifier Auxiliary Adjustment

There is no shortage of fully functional smart humidifiers on the market today, which combine multiple functions in one, saving many users from having to operate them personally. This includes the humidity sensor inside the humidifier to assist in adjusting the humidity of the air in the room so that it reaches a state of constant humidity. Users can also set their own standard of constant humidity, both set their own desired value of indoor air humidity, after the humidifier will work independently at any time to adjust the level of indoor moderation to maintain within the range set by the user.

Image 6.
Smart appliances control humidity
https://unsplash.com/

Pain analysis: this highly automated operation is undoubtedly in line with the current trend of digital technology, but on the other hand, this approach lacks the user's independent control over the product, inhibiting the user's subjective will to adjust the air humidity, but also to discourage the user's enthusiasm to use the product. The work and use of the product to the automated digital technology, and the lack of instinctive emotional communication between the product and the user, reducing the user's attachment to the product.

1.2 Summary of Pain Points

1.2.1 Indication of Numbers

Users can only passively and mechanically follow the instructions of the cold numbers, lacking their own initiative and spontaneity in the process. At the same time, the number or pointer as an artificial abstract symbol is generally not easy to be perceived, so the stereotypical way eventually lead to the user to ignore the attention to air quality and gradually reduce the enthusiasm for the use of humidifiers.

1.2.2 Self-Perception

According to the user's own perception can not effectively adjust the indoor humidity in a timely manner, and will also make the user of the humidifier time into confusion, and eventually gradually lose the enthusiasm for the use of humidifiers, can not form a healthy habit of life.

1.2.3 Constant Humidity Humidifier

The highly automated constant humidity humidifier completely replaces the user's self-help operation, inhibiting the user's subjective will to want to adjust the air humidity and discouraging the user's motivation to use the product.

1.3 Design Objectives

Combined with the above analysis of the pain points of the traditional humidifier control method, the author mainly wants to solve the problem contains:
(1) The lack of clarity in the way humidifiers communicate information about air humidity levels
(2) The user's lack of enthusiasm and permanence in the use of humidifiers
(3) The lack of emotional interaction and attachment to the product of the humidifier
(4) The existence of humidifier cannot significantly help

2. Design Ideas and Significance

users to develop active healthy living habits, but let users passively follow the instructions of the data to complete the operation

In response to the above-mentioned design objectives, I try to explore the use of dynamic product design to convey the information of air humidity, and combine the role of the product on user behavior induction, to explore the user can spontaneously control the humidifier products, and then enhance the emotional communication between the user and the product and the user's durability and attachment to the use of the product, thus helping the user to develop spontaneous healthy habits of life.

Therefore, the author will analyze the dynamic design of the product and the induction of user behavior, and then link the two in order to explore the solutions to the above mentioned pain points.

2.1 Dynamic Design Analysis

2.1.1 From Functional Perspective to Experiential Perspective

Since the third industrial revolution, with the development of digital technology, the industrial products used by people are no longer purely physical products, and the only goal is to fulfill and achieve the purpose of the product. In addition, how to use products more efficiently and conveniently, how to create a better and smoother user experience, has become one of the goals of modern designers.

In addition to completing the basic functions, they also pay more attention to the experience of the whole process of using the product, and can even communicate and interact with the external world by embedding internal sensors, and change and upgrade independently over time.

2.1.2 Modern "traditional" interaction

Due to the development and application of technology, industrial products are always upgrading their interaction and interconnection with users, which makes the boundaries between products and users become increasingly blurred, so products need a "language" to communicate with users.

Many of the novel ways of interaction at the time have even become "traditional" today. One example is the "traditional" interface interaction, where people communicate and operate smart products such as cell phones and computers through touch screens, using the flat visual communication of the interface and the mutual feedback between the user and the product to form the user's communication and operation of the product. Or like Siri intelligent voice assistant hidden in the product, ready to execute the user issued voice commands.

2.1.3 Generation

Most of the traditional digital information dissemination is the use of letters, numbers, icons and other information existing in the virtual interface, so in addition to the user interface and intelligent assistants such as invisible or flat abstract interaction language, can there be a more intuitive and instinctive language of interaction? The reason for mentioning the word instinctive is that the digital economy and interface interaction is only a product of recent decades, and the long evolutionary process of human beings relies on the information transfer method is never a touch interface nor an intelligent assistant, but through the position of the sun to determine the time, through the body's perception of temperature to determine the climate change, through the abnormal behavior of animals to predict the occurrence of natural disasters, and so on. In short, dynamic design is the product through shape, temperature, color, light, smell, sound and other dynamic and three-dimensional way to convey information, and at the same time some dynamic change process can also bring some utility.

Image 7.
Lamp design

Colombo, Sara, Roberto Gorno, and Sara Bergamaschi. 'ENHANCING PRODUCT SENSORY EXPERIENCE: CULTURAL TOOLS FOR DESIGN EDUCATION', 2013, 6.

Image 8.
A conceptual design for indoor climate maintenance in a home

Colombo, Sara, Roberto Gorno, and Sara Bergamaschi. 'ENHANCING PRODUCT SENSORY EXPERIENCE: CULTURAL TOOLS FOR DESIGN EDUCATION', 2013, 6.

Through the following two examples, the author hopes to demonstrate the concept of dynamic product design more clearly.
Example 1: As a lamp design, the shape of the lamp is designed in the form of a flower with a built-in electricity sensor. When the user uses the lamp for a long time and consumes too much electricity, the shape of the lamp will shrink and the proportion of the luminous body will be reduced to lower the brightness, so that the change of the shape will regulate the consumption of electricity. As shown in Figure 1.

Example 2: This is a conceptual design for indoor climate maintenance in a home. The more severe the air pollution, the denser the surface texture, thus reflecting the degree of air pollution by the density of the surface texture of the product.

2.1.4 Disadvantages of Dynamic Design

1) Ambiguity

Interaction interfaces can make the information and intent of the communication concrete on the interface, so that the user can be clear about the type of information and the purpose of the communication. In contrast, the dynamic perception approach is not clear enough, because the way it communicates information is sometimes too metaphorical, which gives the user too much space to think to understand the meaning of the information conveyed by the product, and therefore often leads to misunderstanding.

2) Ambiguity

Compared with the way information is conveyed by numbers and words, dynamic information that is perceived by instinct lacks precision because it is difficult to convey details compared to written information, resulting in quantitative data that is necessarily simplified. For example, numerical information can accurately reflect the percentage of electricity consumption, while dynamic information has difficulty in accomplishing this requirement.

3) Interference

Since dynamic information is communicated from the user's biological instinct, it is too sensitive and difficult to be organized, so if it is not used properly, it will interfere with other normal operations of the user, such as smell, sound, vibration, even if the user does not pay attention to these information for the time being, the information will also be forced to interfere.

2.1.5 Benefits of Dynamic Design

1) Aesthetic Value

Compared with static interface interaction, dynamic products have more aesthetic characteristics because the way information is conveyed in dynamic products on the other hand can also become the dynamic appearance of the product, which provides more possibilities for product form design. For example, in the way of conveying information through the change of

shape, it can be represented by the change of rhythm and rhyme on the product form, which enhances the aesthetic value of the product while conveying basic information for users, and also makes it easier to become the visual focus of many static products and make the image of the product stand out.

2)Intuitive
Compared with static information transmission, dynamic products trigger stronger feedback from people's senses and perceptions. This is due to the fact that dynamic information delivery is derived from human experience over thousands of years, so the information delivered is more easily understood by the user and requires less thought and reaction than interface delivery.

3) Obvious
Dynamic information begins with people's biological instincts rather than the unique creation of an acquired designer, so it is far less expensive to learn than contemporary intelligent interactive products, and users do not need to actively seek out information or pay too much attention to it. For example, the transmission of sounds and smells can be conveyed to the user even from a distance and trigger the user's attention; the change in the intensity of the information originally expressed by numbers can be replaced by the strength of dynamic elements (the remaining power was originally displayed on the screen by numbers, while dynamic products are indicated by the intensity of the light emitted by the indicator)

4) The Power of Urging
Compared with static information communication, dynamic information is more likely to trigger people's emotional resonance and hit the heart. But how to play this advantage depends on the designer's talent, and how to use the characteristics of dynamic products in conveying information at the same time to trigger the user's psychological and emotional fluctuations, so as to guide the user's behavior with more power.

2.2 Connection

The author attempts to explore the induction of user behavior by dynamic products, which means that the basic starting point of this paper will be divided into two parts: both the characteristics of dynamic products and the induction of user behavior. The author has already explored the first part above, and in the following I will also explore the content of user behavior induction.
In my opinion, the important link that connects the two parts is one of the advantages of dynamic products mentioned earlier: the power of urging. Because there is no one way to change user behavior, such as forcing physical constraints is one of the ways, but when it comes to the emotional and subconscious user to urge users to actively change their behavior, product dynamic design has a unique advantage. It is from this advantage that the author explores the link between dynamic design and behavioral induction.

2.3 Behavior Induction

The following hierarchical relationship needs to be clarified here. The title of the author's article is Induction of Behavior, and the main theme of the paragraphs here is behavior change rather than induction. The author believes that there are various ways to change user behavior, and induction is only one of them, so the behavior change discussed here can be considered by the reader as a broad way to influence behavior, not just induction.

2.3.1 The Meaning of Behavior Change

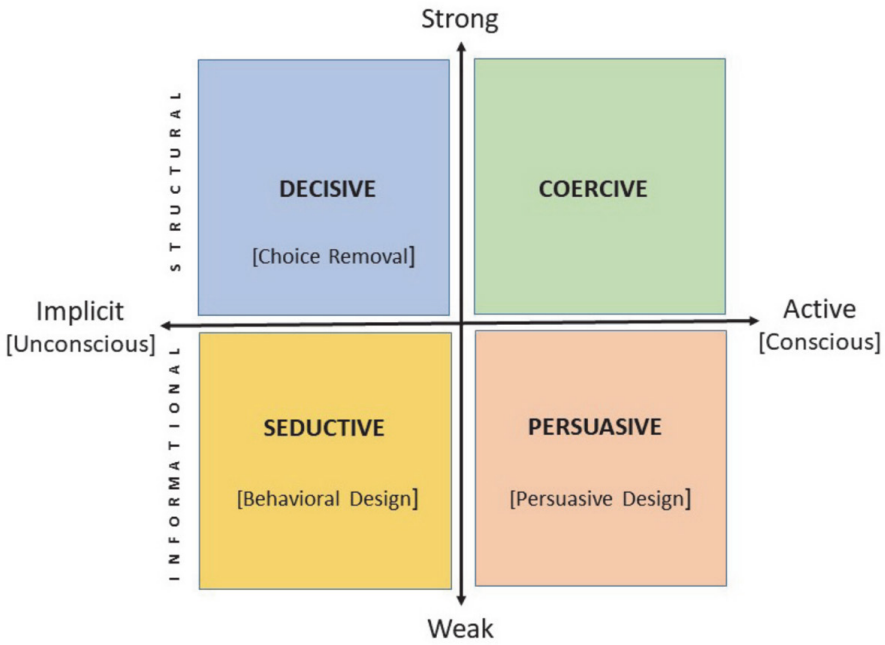
For changing the user's behavior, such wording may go against the design guidelines of thought-based design. Many readers may also question its positive meaning, believing that the user's code of conduct should be the first priority, and the product should cooperate with and assist the user's behavior. In this regard, the author will use green design as an example to re-explain the meaning of changing user behavior.

Initially, the focus of green design and sustainable design was to design products that require less energy and use recycled or renewable materials whenever possible. However, these perspectives were still from an economic and technical point of view and could not bring about changes in user behavior, so it was suggested that industrial products should also influence users to make the right choices. With that, people realized that the meaning of green design and sustainable design is not only from the product itself, through optimizing the product to achieve energy saving and sustainable purpose, but also from the user's behavior way, through design to influence and change the user's behavior, so the term low carbon life was born.
Through the case of green design, the author hopes to convey the meaning of changing user behavior accurately. However, it has to be admitted that when it comes to behavior change it also means violating the original intention of the user's psychology, but the reason for changing user behavior is often because such behavior is required by the social and moral way. Therefore, a socially beneficial way of behaving often does not necessarily lead to a good personal experience. So the designer's task is to influence individual behavior through the product to a socially beneficial way, and in the process not to strike the user's original psychological original intent and experience as much as possible, depending on the designer's wisdom.

2.3.2 Ways to Change User Behavior

The second criterion is whether the method is metaphorical or explicit, whether the method is used to influence the user consciously or subconsciously, in other words, whether the user can clearly perceive the influence and intervention. In other words, the user can clearly perceive the presence of this influence and intervention, and thus whether he or she changes his or her behavior consciously or subconsciously. To summarize, we can establish a right-angle coordinate system to classify the ways of influencing users' behavior into four types: decisive, coercive, seductive

and persuasive, depending on the range of influence from strong to weak and from metaphorical to explicit.



1) Decisive

The position in the coordinate system shows that this way of influencing is strong, yet metaphorical and acting on the user's subconscious. The design is decisive when it makes the desired user behavior the only possible behavior.

Case study: The design is a German hotel door lock design. In order to prevent the guest from forgetting to unlock the door after entering the room, the process of using the key in the hotel is designed in such a way that when the key is inserted to open the door, the user will not be able to pull it out in the normal way, but must pass the key through the lock hole, close the door from the room and unlock the door before the key

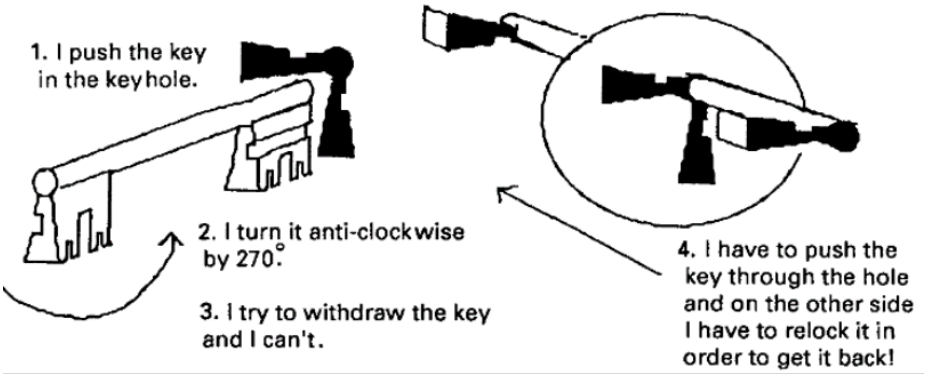


Image 9.
Four ways to influence user behavior
Colombo, Sara, Roberto Gorno, and Sara Bergamaschi. 'ENHANCING PRODUCT SENSORY EXPERIENCE: CULTURAL TOOLS FOR DESIGN EDUCATION', 2013, 6.

Image 10.
German hotel door lock design
Colombo, Sara, Roberto Gorno, and Sara Bergamaschi. 'ENHANCING PRODUCT SENSORY EXPERIENCE: CULTURAL TOOLS FOR DESIGN EDUCATION', 2013, 6.

can be removed from the lock hole in the room. This is shown in Figure 4. This approach is first of all mandatory because it creates a physical constraint that leaves no other choice for the user, who can only follow the designer's intention to remove the key and accomplish the behavior that the designer wants the user to change during the whole process. But at the same time it is also metaphorical and starts from the user's subconscious, because the user does not have the consciousness to change his or her mind during the whole behavior, everything is in compliance with the established activity lines and rules.

2) Coercive

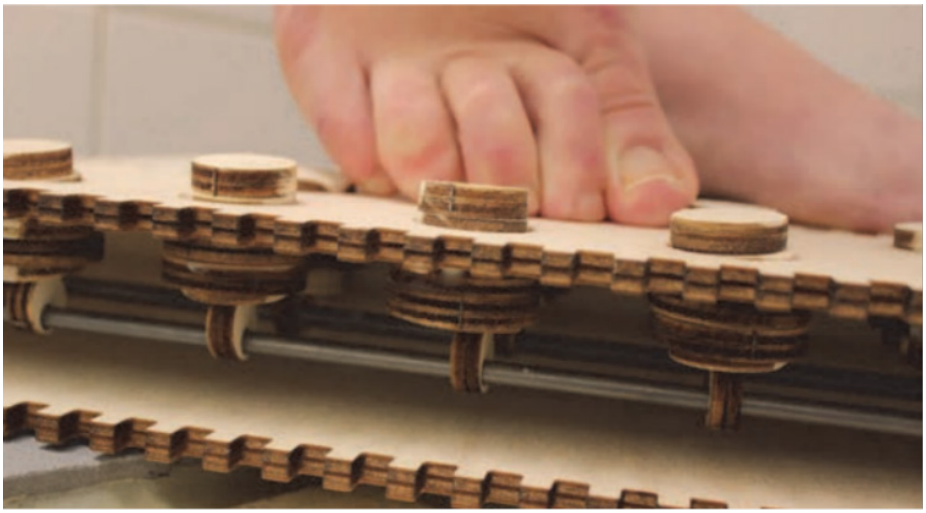
This approach to change is first and foremost mandatory and powerful, and the user will recognize the existence of this intervention at a conscious level and thus actively change their behavior rather than being driven and guided unconsciously.

Case study: A typical example is the car speed bump on the highway. First of all, this intervention is undoubtedly powerful, because after the user finds the speed bump, if he still drives through it at high speed, it will undoubtedly create a safety hazard, and the threat posed by this hazard will force the driver to slow down and pass. On the other hand, when drivers see the speed bump, they will consciously change their original speed and apply the brakes to pass, so this way is also clearly to influence the user's behavior from the conscious level. As shown in Figure 5.

Image 11.
Car speed bump
https://soso.nipic.com/?q=%E5%87%8F%E9%80%9F%E5%B8%A6

3) Seductive

This approach differs from the two previous coercive change strategies, but has only a weak ability to influence, that is, it still leaves the user with a choice, rather than coercively setting the designer's desired choice as the only option for user behavior. At the same time, this approach is metaphorical and subconscious.
Case study: This is a shower basin design that prompts users to conserve water, consisting of an enclosure and a number of soft pins that pop up randomly. The tray at the bottom moves in different rhythms while the user is showering, creating a tactile experience similar to a foot massage each time. And when the user's bath time reached the average length of the bath, the massage device will gradually stop working to imply the completion of the user's bath. So the user will subconsciously think that his bathing process should also end, rather than spend more time unnecessarily bathing and cause a waste of water.



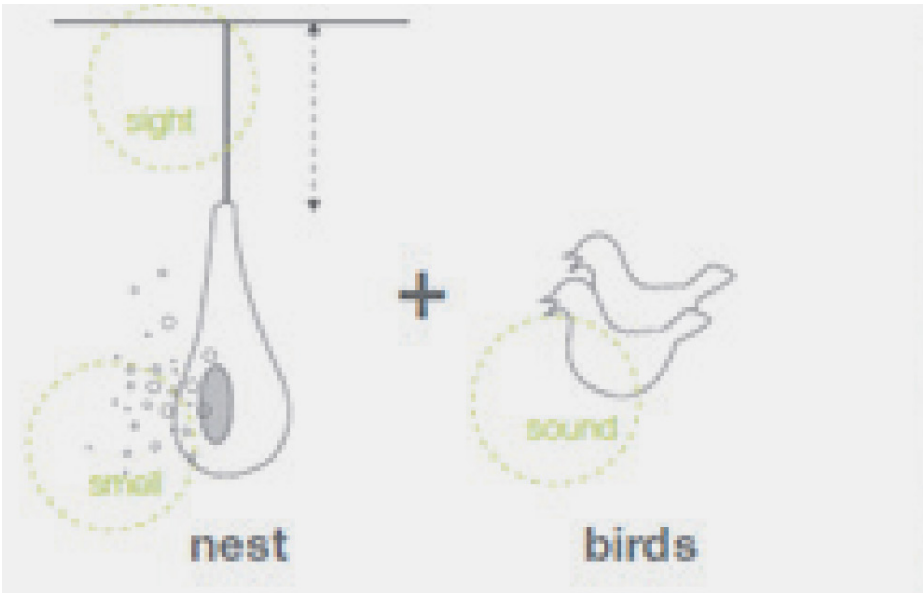
4) Persuasive

The persuasive approach is similar to the seductive one, in that it is a weak behavioral intervention that leaves the user with full freedom and choice. But it also works on a conscious rather than a subconscious level, which means that the user is aware of the product's intervention, but it is not mandatory.
Case study: The concept of peaceful time focuses on making "negative" times (when peaks occur) beneficial to users in some way. In fact, peak times are

Image 12.
Shower basin design

Colombo, Sara, Roberto Gorno, and Sara Bergamaschi. 'ENHANCING PRODUCT SENSORY EXPERIENCE: CULTURAL TOOLS FOR DESIGN EDUCATION', 2013, 6.

emphasized as times when users can relax and do other things, i.e. "peace time". When "peace time" begins, an ambient sensory interface informs the user that it is time to rest and relax. The ambient interface includes a "nest" suspended from the ceiling and a group of wooden birds placed around the house. When peace time begins, a fragrance is released from the nest into the house. The perfume is selected by the user from a set of natural scents (e.g. wood, flowers) that establish a connection with nature. A pleasant bird song (made by a wood bird) marks the thirty and fifteen minutes before the start of peace time. These birds can be placed in a bird's nest or elsewhere in the house to alert the user that peace time is approaching.



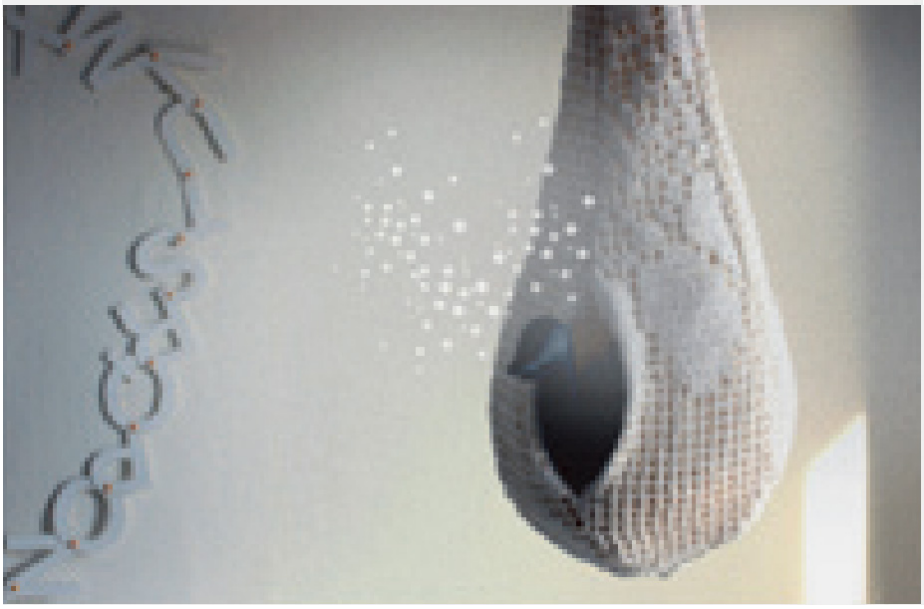


Image 13.
The concept of peaceful time focuses on making "negative" times

Colombo, Sara, Roberto Gorno, and Sara Bergamaschi. 'ENHANCING PRODUCT SENSORY EXPERIENCE: CULTURAL TOOLS FOR DESIGN EDUCATION', 2013, 6.

How to Choose Them

There is no absolute good or bad, superior or inferior, for the above four ways of changing user behavior, but rather what is the appropriate way to apply them in which situation.

In general, the decisive and compulsive approaches are undoubtedly the most effective, but they may also bring about a not-so-good user experience because they mechanically prescribe or constrain the user's right to choose, and sometimes even easily annoy the user, so designers should be careful when using such approaches. Therefore, the author believes that it is appropriate to apply these two methods when there are more serious consequences for users who cannot change their own behavior, and they regulate the basic and necessary needs. For example, as mentioned above, the driver may cause more serious safety hazards if he cannot slow down as required, in this case it is necessary to use coercive influence methods, using speed bumps to force the driver to slow down, even though this may annoy the driver, but this is the designer's choice in weighing the pros and cons. Seductive and persuasive approaches, on the other hand, have only a weak influence, but they create and sustain a good user experience as they create cognitive and emotional changes and leave the user with full choice. These two approaches are also used in the opposite scenario to the deterministic and coercive approaches, and are applied to social and human needs, both even if the user chooses to behave in other ways on their own without serious consequences.

2.4 The Application of Product Dynamic Design in Inducing User Behavior

2.4.1 Application Method

As I mentioned above, the reason why the concept of combining product dynamic design with user behavior induction is derived is that dynamic design has the advantage of persuading and urging users, because the information conveyed by dynamic design is not an intelligent form of interaction developed in recent decades, but a back-to-basics five-sense experience from biological instincts that has been used for thousands of years by humans and even other creatures and communication methods. The effect of this advantage is to change and influence the user's behavior while still being a good experience for the user, and even influence the user's perception. Therefore, as shown above, when it comes to the choice of influence methods, the category of dynamic design should act on the two ways of seductive and persuasive, because these two ways are from the user's instinctive behavior. If the user's behavior is to be changed in a strong way, there is no need to use dynamic design as a euphemism. In the specific implementation, whether to use the induced or persuasive method, both from the user's conscious level or subconscious level to induce user behavior, depends on the specific implementation and the designer's idea. In my opinion, when implementing dynamic design, it is necessary to take advantage of dynamic information to evoke the user's instincts or emotional resonance from past experiences, so that the product's intervention will not seem abrupt, whether on the user's conscious or subconscious level, and the user's behavior will be changed in a logical way from the heart.

2.4.2 Application Areas

Since product dynamic design influences users through seductive and persuasive approaches, it is logical that the nature of the application domain should correspond to the application domain of these two approaches. As mentioned earlier in this paper, the deterministic and coercive approaches are mainly applied in the basic and necessary domains, where the user's behavior is rigidly required. Whereas seductive and persuasive act in social and humanistic domains, with more focus on service and experience. Therefore, the application area of dynamic design for behavioral enticement should also be social and experiential, and is a need that further develops after the basic needs are satisfied. Therefore, the author believes that there are currently several domain categories that can be applied, such as low-carbon life, healthy life, behavioral ethics, business planning, which can be applied to the above domain categories.

Image 14.
Healthy lifestyle habits
https://unsplash.com/

The author has already discussed the meaning of dynamic design and user behavior induction separately above, but combining the two can have a deeper meaning. When we only look at dynamic design, it has many applications, such as more obvious message communication, fulfilling some functional requirements in the process of dynamic change, as an art installation or bringing sensory pleasure, etc.. The change of user

behavior from dynamic design proposed by the author is a different direction.

First of all, as I have mentioned many times, the form of dynamic design originates from the stimulation of users' five senses, and this stimulation originates from users' biological instincts, and its influence on users' behavior is much greater than the symbolic stimulation of two-dimensional planes, so using dynamic design to change users' behavior is an efficient and novel breakthrough.

Secondly, dynamic design creates more possibilities for product form, which satisfies the user's sensory experience and is also more conducive to allowing the product to convey the symbolic semantics of form, because most things in time are not immutable, but change with the shift of time or space, such as the blooming and wilting of flowers, the angle and color change of sunlight during the day, etc., and these changing processes, the general Static product form is unable to meet, and dynamic products are more conducive to play these semantic symbols, and these semantic symbols are more likely to evoke the user's emotional resonance, evoke the user or biological instinct in the past experience, whether empathy or empathy, can let the user from the emotional intertwined with the product, and thus profoundly affect the user's behavior.

Third, because dynamic design works in the realm of seductive and persuasive in the approach of behavioral induction, rather than mandating prescribed behavioral change, and because of the nature of dynamic design in biological instinct and semiotics, this combined approach is more persuasive and sustainable in terms of user behavior change, allowing users to not only change behavior, but to form habits.

Fourth, because of the continuity of the dynamic design of the product on the impact of user behavior, it means that users have emotional resonance in the process of use and also in the continuous emotional input, which is conducive to user reflection and attachment in the process of use, so that users are not easily bored with the product, which can become a reason for users to

love the product and continue to use the product, but also to improve the use rate and length of use of the product. This can become a reason for users to love the products and continue to use them, and also increase the usage rate and length of use of the products, which eventually improves the value of each product, thus indirectly achieving the purpose of sustainable development.

2.5 Integration with Humidifier Design

2.5.1 Humidifier Combined with Dynamic Design and Behavior Induction

In summary, the author will use the basic method of product dynamic design, the product to the five senses of the way to communicate information combined into the humidifier, with a more obvious, instinctive way to communicate information about the air humidity level to the user, to evoke the user's memory of past experience,

Image 15.
The basic functions and styles of humidifiers
https://unsplash.com/

so as to induce the user from the instinctive behavior to influence and change the user's behavior, while retaining the user's full control of the product In addition to retaining the user's full control over the product, the user can take the initiative to adjust the unsuitable air humidity level, and then strengthen the emotional communication and attachment between the user and the product, so that the user can reflect on the invisible, develop healthy living habits, and subjectively use something to gain and learn after the product experience, instead of being swayed by the physical limitations of the product.

2.5.2 Combination of Humidifier And Product Semantics

The product is based on the concept of dynamic design, which conveys a more obvious message to the user, and later uses the methodology of product design to induce user behavior, so that the user controls and uses the product from the instinctive subconscious. But on the other hand, the product itself must be able to trigger the user's thinking, trigger and evoke the user's previous life experience, so as to change the user's behavior from the subconscious level. Therefore, I believe that the semantics of product form in semiotics should be introduced in the form of the product, so that when users see the product, it can trigger their reflections and thus change their behavior.

The following are the theoretical reasons and background analysis of the author's view that product semantics should be involved.
Product semantics is the study of the symbolic characteristics of man-made objects in the context of use, and how to apply them to industrial design. With the development and progress of society, the great abundance of materials, and the further refinement of consumption levels, people's demand for the spiritual functions of products has been increasing. In addition to expressing their functional purposes, product shapes should also convey the cultural connotation of products

through their semantic characteristics, reflecting the sense of the times and value orientation of a particular society. This not only refers to physical and physiological functions, but also includes psychological, social and cultural aspects known as symbolic environment.
Product semiotics believes that users have two kinds of motives when operating and using products. One is to balance the feeling, consistent with the relevant feeling. For example, when users feel that the air is dry they will remember to use a humidifier to regulate it, but this motivation is often lagging and inefficient. The other is the motivation caused by the purpose of action, for example, if the humidifier is combined with a certain imagery, when the user sees the imagery conveyed by the humidifier, the motivation for the user to use the humidifier is not the feeling of their own, but transferred to the feeling of the imagery conveyed by the humidifier, thus evoking the user's empathy and awareness of air humidity, prompting the user to use the humidifier so as to form good habits.

Image 16.
People's empathy and care for organic life
https://unsplash.com/

(1) Production Technology Perspective
The rapid development of various modernist design activities, all of which have made industrial design a truly independent discipline. It emphasizes the principle of function first and form second, pursues new forms of material expression, and focuses on the prominence of function. With the advent of the third technological revolution, the "computer age", the original link between form and function of industrial products was weakened, and the form of electronic products did not express the structure and function as clearly as mechanical products, resulting in "black box" and "homogenization". The phenomenon of "homogenization" has emerged. The "form and function in one" modeling law is no longer reflected in the product design. The development of technology has narrowed the gap in function and performance between the products produced by various enterprises, and the use of differences in appearance has become an important means of market competition. At the same time, the other tenet of modernist design, that the formal structure of a product should reflect its function as clearly as possible, has become meaningless.
(2) Consumer Perspective
The development of technology has narrowed the gap in function and performance between the products produced by various enterprises, and the use of differences in appearance to compete in the market has become an important means. At the same time, the other tenet of modernist design - the formal structure of the product reflects the function as faithfully and clearly as possible - has become meaningless. The pursuit of change and freshness, practicality, the desire to have cultural meaning, artistic interest in post-industrial products. The cheaper production cost of products greatly stimulated consumers' desire to buy, and the former luxury goods became used and discarded at this time. A series of design principles advocated by modernist design - from the reliability and durability of product performance to the robustness of product style and the inappropriateness of obsolescence - were no

longer appropriate, and physical functions were clearly no longer sufficient to meet people's needs. The styling principle of "form and function in one" is no longer a necessary principle.

(3) Social Perspective

International modernist design used simple mechanical methods to make glass curtain wall buildings the symbol of developed capitalist countries, and all major cities around the world became the same: glass curtain wall buildings, steel furniture, and reductionism became the core elements of international modernism, and the urban environment that was integrated with tradition and nature became a forest of glass curtain walls and reinforced concrete. People were forced to face the fact that "human beings are part of nature", which prompted them to consider many new issues, such as the symbiosis between human and nature in ecology, recycling with limited petrochemical resources, environmental protection in the third world, the proliferation of products, consideration of the use environment, and so on. At this time, the "environmental function" and "dialogue function" of products began to be emphasized, and people not only wanted to meet the physical and physiological use value, but also the psychological, social, cultural and environmental symbolic value.

(4) Cultural Perspective

During the development of modernist design, several emerging disciplines have received unprecedented attention and development, such as ergonomics, material mechanics, design ecology, environmental psychology, marketing, sales, etc. A series of laws, rules and disciplines of industrial design in terms of function and structure have been largely known to people, and the rational and reasonable requirements have almost been discovered and utilized by designers, forcing people to find a new language in design. The methods, procedures, market research, and plans for product design are becoming more and more perfect, and they are becoming standardized programs. The similarity in design and the lack of individuality in style has led to

a renewed discussion and international interest in the identification of design culture. The design concept of "function first" and "structure first" caused the geometric style to become rapidly popular around the world, and product design tended to be monotonous, simple, indifferent, rigorous and lacking in human feelings. The design culture and aesthetic characteristics of each nationality and the regional individual style were brutally abandoned and disregarded, and the psychological needs of users were ignored. The development of industrial power as a purely technical state can be borderless, but once industrial power is combined with ideology, it is no longer possible to be "international". People cannot bear to live without spirituality, which is always associated with specific cultural and historical traditions. We began to hope that traditional culture and technological culture could be symbiotic and complementary, that they could be regarded as equal, and that they could seek a typical cultural reconstruction in terms of "the meaning of the shape of life". In the above-mentioned aspects of continuous and rapid development, product form design should not only consider the physical and physiological functions of people, but also go deeper into the psychological and spiritual factors of people, requiring the search for psychological, social, environmental and cultural veins, and giving symbolic characteristics, so the rise of product semantics is also logical.

2.6 Summary of Design Implications

Comprehensive description of the previous article, the pain point of humidifier is triggered by the inefficient way to communicate information, it is not easy to make users aware of the air humidity level and start using the humidifier, so I introduced the concept of product dynamic design. After that, the concept was deepened, and the dynamic design conveyed instinctive information, which was conducive to making users change their behavior from the subconscious and develop continuous healthy habits, so the author again introduced the concept of user behavior induction.

Finally, in the specific implementation of product design, the author needs to introduce product form semantics and semiotics as a tool to compare the product to a real living body, so as to evoke the user's instinctive consciousness in the form, so that the product and the user symbiosis in the same environment, the product's environmental conditions are both the user's environmental conditions. The product's environmental condition is the user's environmental condition. Thus, the user's empathy and care for the product is realized, and the user's behavior pattern is changed from the instinctive level.

Image 17.
People's empathy and care for organic life
https://unsplash.com/

As shown above, the inherent concept of the design is supported by the three concepts of product dynamic design, user behavior induction, and product form semantics, which serve as the basis for the entire pre-product concept output.

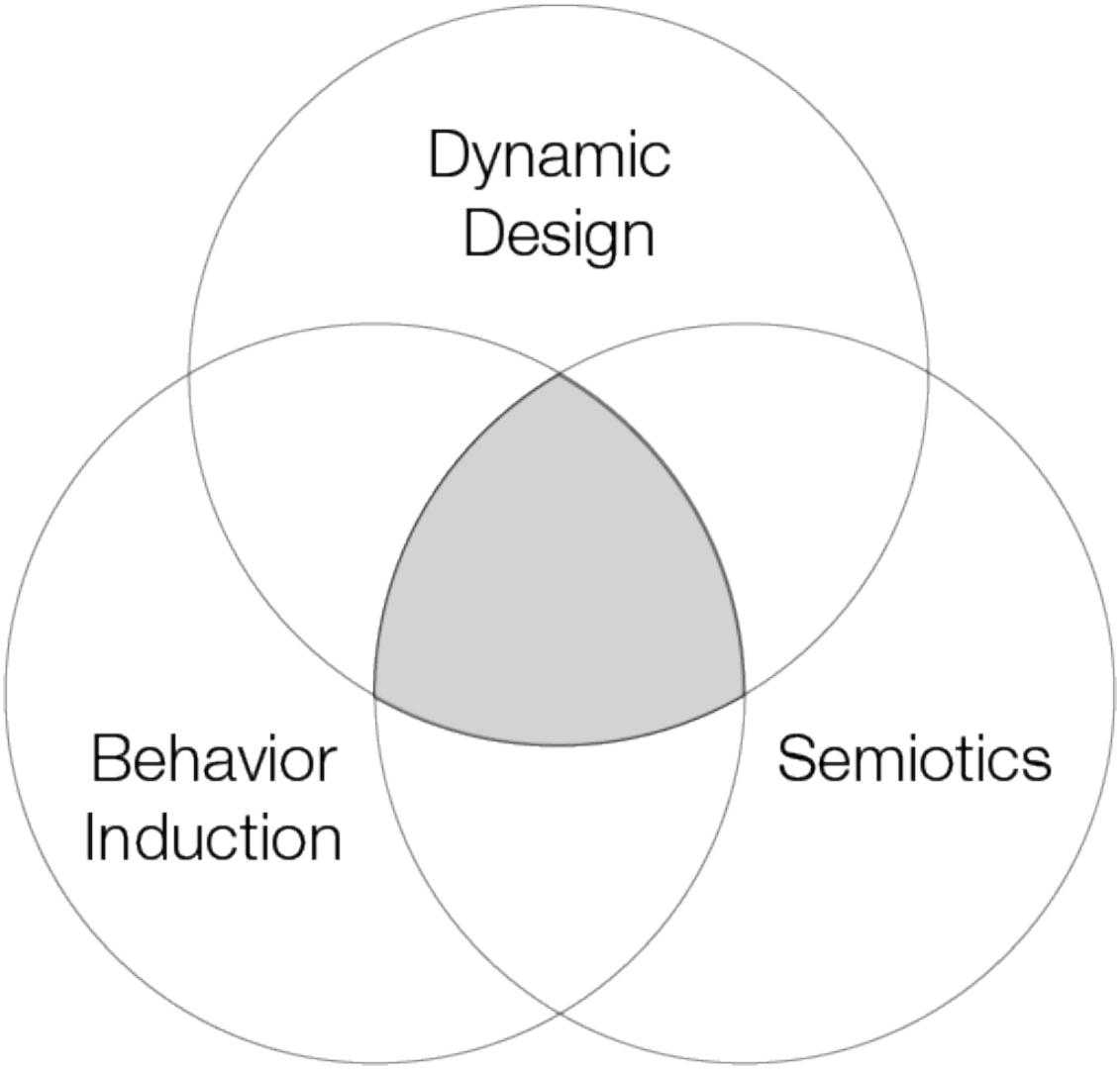


Image 18.
The inherent concept of the design

3. Product Research

3.1 Definition of Humidifier

3.1.1 What Is Humidifier

Humidifier therapy adds moisture to the air to prevent dryness that can cause irritation in many parts of the body. Humidifiers can be particularly effective for treating dryness of the skin, nose, throat, and lips. They can also ease some of the symptoms caused by the flu or common cold.

Image 19.
Indoor use scenario of humidifier
https://www.amazon.in/Pure-Enrichment-Ultrasonic-Cool-Humidifier/dp/B01M06T0RA

3.1.2 What Can We Use A Humidifier for

Humidity acts as a natural moisturizing agent that can relieve dryness. For this reason, humidifiers are often used for relieving:

dry skin
sinus congestion/headache
dry throat
nose irritation
bloody noses
irritated vocal cords
dry cough
cracked lips

3.1.3 How to Safely Use a Humidifier

Before operating a humidifier in your home, you should be aware of some of the risks and safety precautions of these devices to avoid adverse health reactions.

(1) Manage Humidity
Don't add too much moisture to a room. You don't want the humidity in a room to be at more than 50 percent. When the humidity exceeds this percentage, bacteria and mold can grow. This can trigger respiratory conditions like allergies and asthma.
Ideally, the humidity of a room should be between 30 and 50 percent. You can purchase a hygrometer
Only run your humidifier when you need it, not all of the time, to keep humidity levels down.

(2) Use Distilled Water
Another health risk when operating a humidifier relates to the particles other than water emitted into the air. Unhealthy mineral particles can be released by a humidifier, particularly with cool mist machines. Distilled water has fewer minerals in it and can be purchased for use in your humidifier.
Purchase distilled water for humidifiers.

(3) Keep Your Machine Clean
You should always clean your humidifier after every use and make sure the water tank gets completely dried before using it again.
Rinse and replace the water in your humidifier's tank each night to avoid using old standing water that may contain molds or other bacteria or fungi.
You may notice white buildup within the humidifier. This is known as scale and could be emitted into the air and cause particles to enter the lungs, leading to health problems.

To avoid or remove scale or mold, clean your humidifier out every few days with a water and vinegar or hydrogen peroxide mixture or with another cleaning solution recommended by the manufacturer.
You should consider replacing an older humidifier if it hasn't been cleaned regularly.

3.2 Classification of Humidifier

3.2.1 Central Humidifiers

Central humidifiers are built directly into your home's air conditioning or heating unit. These are the most expensive types of humidifier, but they're the best choice if you want to add humidity throughout the entire house.
Traditional humidifiers carry a potential risk of burns from the steam they emit. Central humidifiers don't emit steam.

3.2.2 Evaporators

Evaporative humidifiers are cool mist humidifiers. A fan pulls air from the surrounding area into the humidifier and pushes it through a moistened wick that is submerged in water. The water evaporates into the air, creating humidity. This also cools the air in the process, making it a good choice in warmer climates.

3.2.3 Steam Vaporizers

Steam humidifier heats water to a high temperature and releases the moisture into the air in the form of steam vapor. Many of these humidifiers heat the water enough to destroy irritating compounds like bacteria, algae, and mold. This makes allergens less likely to be released into the air than other types of humidifiers.

3.2.4 Ultrasonic Humidifiers

Ultrasonic humidifier mainly uses high-frequency vibration, and then through the high-frequency vibration of the atomizing sheet, the water in the humidifier is thrown away from the water surface to generate an elegant water mist to achieve the purpose of air humidification.

Image 20.
Central Humidifier
https://www.walmart.ca/en/ip/Air-King-BFQ-110-BFQ110-Exhaust-Fan-100-CFM/PRD5KPC5CVLUIG7

Image 21.
Evaporator
https://www.walmart.ca/fr/ip/Vornado-Evaporative-Whole-Room-Humidifier-with-Simple-Tank-1-Gallon-Capacity/PRD1TUJOGK0Z8YO

Image 22.
Steam Vaporizer
https://www.amazon.in/Mievida-Inhaler-Vaporizer-Steamer-Temperature/dp/B08X2BRC66

Image 23.
Ultrasonic Humidifier
https://pureenrichment.com/products/mistaire%E2%84%A2-drop-ultrasonic-cool-mist-humidifier

	central humidifiers	evaporators	steam vaporizers	ultrasonic humidifiers
Context	Whole space inside	Separate room	Separate room	Separate room or private limited area
Adjustment range	Control humidity levels throughout the house	Control humidity levels in individual rooms	Control humidity levels in individual rooms	Control humidity levels in individual rooms or limited areas
Volume	Larger volume, installed with air conditioning and heating	Medium size，complex structure	Medium size，complex structure	Medium or portable，simple structure
Advantage	Does not occupy indoor space, large humidification range and high efficiency	High humidification efficiency and less air pollution	Highest humidification efficiency and least air pollution	Low noise, simple structure, easy to carry
Disadvantage	High cost and installation costs.	Noisy and inconvenient to clean	High working temperature, there is a safety hazard，High energy consumption	The humidification effect is average, and the air pollution is high

Table 1.
Comparison of the characteristics of four types of humidifiers

3.3 Detail Comparison And Selection Criteria

Since the design purpose of this project is to reasonably use the concept of dynamic design to induce users to actively use the product, the selection criteria for humidifiers are based on the reasonable implementation of the above design purposes.
Therefore, for example, humidification efficiency, usage scenarios, etc. are secondary considerations. The product volume, structural complexity, cost, etc. are the main factors to be considered.
To sum up, because the ultrasonic humidifier has a simple structure, low cost, and moderate volume, it is suitable for adding dynamic interaction. Therefore, the author decided to use the structural principle of the ultrasonic humidifier as the matrix to improve the design. And because the three humidifiers except the ultrasonic humidifier are all large and block, it is not conducive to the dynamic design innovation in the shape, while the ultrasonic humidifier is more flexible in shape and has fewer constraints, which is conducive to giving full play to the the advantage of dynamic art.

3.4 How Ultrasonic Humidifiers Work

3.4.1 Atomizing Tablets

The principle of the ultrasonic humidifier is to use overfrequency oscillation (the oscillation frequency is 1.7MHz, and there are also 2.4MHz), and by using the high-frequency resonance of the atomizing sheet, the water droplets are broken into tiny floating particles of about 5 microns, which are used in the fan or the fan. In the natural state, it is far away from the water surface, so that the suspended water mist is continuously generated, and finally the air is humidified. Because 1.7MHz exceeds the human ear hearing, so the ultrasonic humidifier is derived from it.

3.4.2 Power Supply

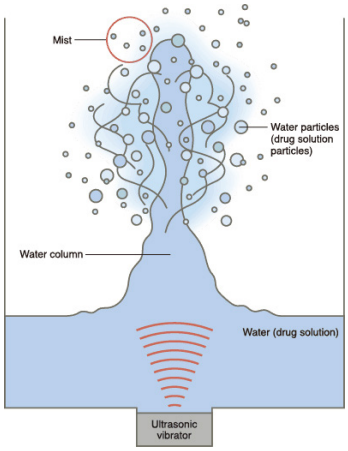
The power supply part is generally two-way input, one is to supply power to the fan, and the other is to supply power to the vibration board. If the vibration board has the same voltage as the fan, it can be used as one channel. If the power supply board uses a transformer, after step-down, rectification and filtering, the oscillation circuit and the fan are powered. This is relatively simple and simple compared to the switching power supply circuit, but the transformer is also too bulky, especially for mini humidifiers. It can be said to be a burden, but the circuit design of switching power supply is sometimes a little more complicated, depending on the actual situation.

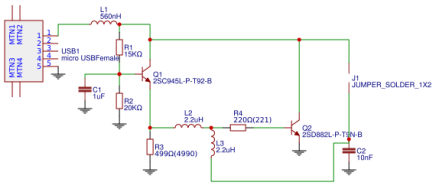
3.4.3 Rotary Angle Sensor

The function of the power switch here is to turn on the power. If the potentiometer adjusts the fog volume, the starting position of the potentiometer is the position where the power is turned on. When the potentiometer turns on the power, it also starts to adjust the humidification volume, but if the PWM signal is used to control If so, this connection position can be directly short-circuited.

Image 24.
Atomizing Tablets
https://www.honda-el.net/industry/HM-2412-e1.html

Image 25.
Power Supply
https://bbs.csdn.net/topics/397383427





3.4.4 Water Level Detection

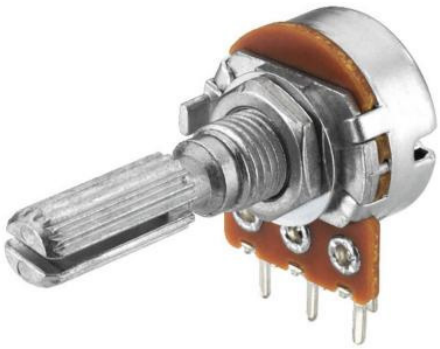
Most of the water level detection now uses a magnetic reed switch and a magnetic ring to detect whether there is water shortage. A reed switch is a magnetic sensitive switch, usually made of two soft magnetic materials. Simply put, the two reeds are not in contact when there is no external magnetic field, and will close once they encounter a sufficient magnetic field. Therefore, when there is no water shortage, the magnetic ring is floated by the water, the magnetic field closes the magnetic reed switch, the control board detects the change of the signal, the oscillation circuit starts to work, the green indicator lights up, and the humidification is turned on at the same time; Cause the magnetic ring to be far away from the reed switch. At this time, the contact of the reed switch is opened, the humidifier stops humidifying and disconnects all outputs, and the red shows the water shortage state at this time. There is also a water surface probe to detect water shortage, which is less used.

3.4.5 Fan Output Control

The fan voltage is generally 12V, 24V, 36V, etc. The shock board breaks up the water droplets into tiny particles and continuously blows them away through the fan, so that water mist is continuously formed. When the lack of water is detected, the fan is also turned off at the same time.

3.4.6 Humidity Sensor

Some humidifiers have constant humidity control or automatic humidity adjustment, which means that the humidifier needs to have a humidity sensor inside.
By setting the humidity level by the user, the humidity sensor will control the operation of the humidifier by detecting the humidity level in the room.



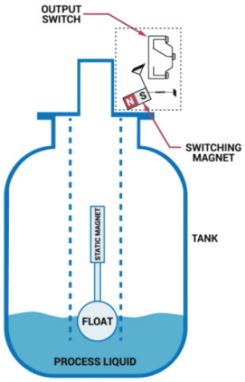


Image 26.
Rotary Angle Sensor
https://www.digikey.sg/zh/products/detail/bourns-inc/PDB181-K420K-203B/2564752

Image 27.
Water Level Detection
https://www.akmueller.de/en/float-valves

Image 28.
Fan Output Control
https://www.taobao.com/list/item/537765086281.htm

Image 29.
Humidity Sensor
https://www.amazon.it/DealMux-CHR01-2025-sensore-Terminali-Deumidificatore/dp/B072TW7R9K

3.5 Functional Details of Ultrasonic Humidifier

3.5.1 Classified According to Water Storage Capacity

For different use environments and needs will have different sizes of humidifiers. Different sizes mean that the capacity of the water tank is different, and the larger the capacity of the water tank often means that the humidifier can continue to work for a longer period of time after filling a water tank.

3.5.2 Classification According to Humidification Speed

At the same time, the humidifier can also be divided according to the power, the larger the power, the larger the effective humidification area of the humidifier. A large humidifier can humidify a space of 30-50 square meters, while a small humidifier can only humidify a table space of 1-2 square meters.

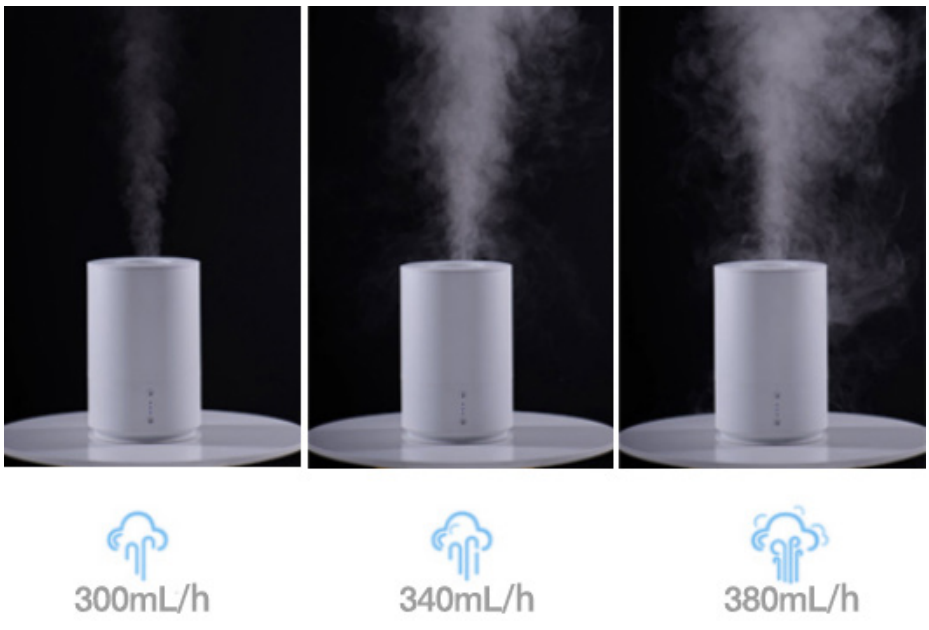


Image 30.
Classification According to Humidification Speed
https://www.nexhc.net/aroma_diffuser756/16.html

3.5.3 Auxiliary Function

(1) Soften And Filter Water

Some categories of humidifiers can be installed inside the water tank to soften and filter the water, which can be used for the initial cleaning and filtration of the water used in the humidifier.

(2) UV Disinfection

Some humidifiers will have a UV lamp module inside the base, which can disinfect the water inside the humidifier at a deeper level.

(3) Ambient Light

Some humidifiers are not only used as a product to regulate air moderation, but also as a night light or ambient light to provide night lighting or to set the mood.

(4) Air Purification

Some of the larger power humidifier also combines the function of humidification with the function of air purification, so that the gas discharged from the humidifier is both moist and clean.

(5) Aromatherapy

Some humidifiers also provide the auxiliary function of aromatherapy, so that the discharged mist has a fragrance. One way to achieve this purpose is to have an aroma box inside the humidifier, the user will add essential oil to the aroma box, so that it is in contact with the humidifier discharge mist; the second method is to directly drop the essential oil into the water tank of the humidifier, so that the water in the tank with aroma, and spread into the air by the humidifier.

(6) Remote Operation

Some high-end humidifiers have the auxiliary function of remote control. There is the use of remote control to remote control in the room, another category can also be synchronized with the APP on the phone through the network in the room, thus achieving a more remote network remote control.

Image 31.
Soften And Filter Water
https://www.sunsky-online.com/zh_CN/p/HAP6910/

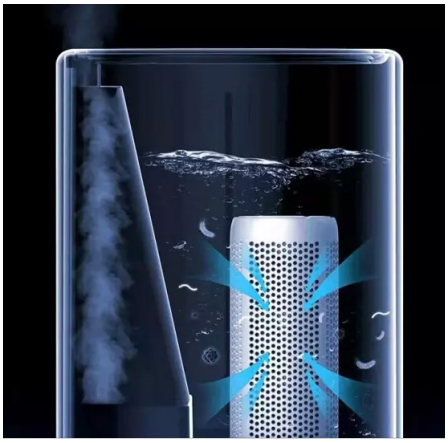
Image 32.
UV Disinfection
https://www.electrogor.ru/telefon/uvlazhniteli.html/nid/102992

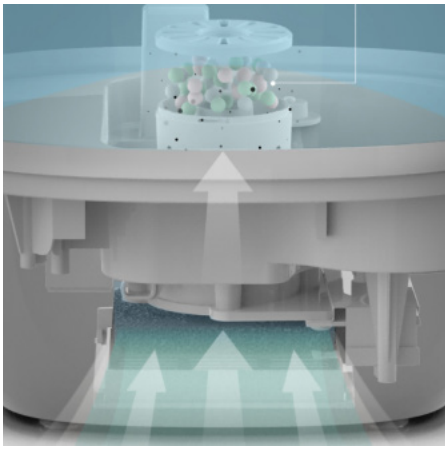
Image 33.
Ambient Light
https://zhuanlan.zhihu.com/p/365033372

Image 34.
Air Purification
http://www.balmuda.com/downloads/pdf/ERN-1080_CN.pdf

Image 35.
Aromatherapy
https://www.facebook.com/profile.php?id100062989635982

Image 36.
Remote Operation
https://chinese.alibaba.com/product-detail/2021-Universal-Ceiling-Fan-and-Light-60778301757.html





3.5.4 Context

(1) Home Environment
Suitable for medium or large humidifiers

(2) Desktop Office Environment
Suitable for small or micro humidifiers

Image 37.
Home Environment
https://sourcing.hktdc.com/zh-Hans/Product-Detail/Top-filling-humidifier-with-humidity-sensor/1Z03HZZFS?ref_sourceTopNew&ref_mediumN

Image 38.
Desktop Office Environment
http://www.zljlp.com/Mobile/MProducts/qcjsq.html

3.6 Four Basic Structures

3.6.1 Humidifier with Top-Fill Water Structure

The advantage of this way of filling water is convenient and quick, the user does not have to carry the water tank to the toilet or kitchen to receive water, but can always add the water around directly to the humidifier, without moving the humidifier. Sometimes you can even drink your own leftover water directly into the humidifier, convenient and fast.

This structure requires a trigger inside the humidifier, when the water needs to flow into the atomizer area is, the trigger will automatically detect and open the valve in the lower part of the water tank.

3.6.2 Humidifier with Lower Water Filling Structure

This structure of the humidifier has a separate water tank, when adding water users need to separate the water tank and humidifier base and invert the tank, add water from the bottom of the tank, and then put the tank back on the humidifier base. This is more complicated and inconvenient to operate than the upper filling method.On the other hand, this way of adding water from under the tank becomes a closed space, when the level of the atomizer space decreases, due to the principle of the linker, the water in the tank will flow through the atomizer area by itself because of the connection with the atmosphere, until the water level in the atomizer area is higher than the position of the tank valve, the water will stop flowing by itself. Therefore, this way eliminates some automated mechanical structures.

3.6.3 Desktop Humidifier

This structure is similar to the humidifier on the water, but the working area of the atomization piece in this structure is integrated with the sink, directly set in the inner surface of the sink, there is no independent flower-free space, so there is a clear limit on the amount of water and power of the humidifier, generally in 300-400ml, power in 10-15W.


500ml
H2O
HUMIDIFIER

3.6.4 Mini Humidifier

This type of humidifier uses a special way of use, so that the body of the humidifier is located above the water surface, the need to rely on cotton swabs to absorb water to the location of the atomization piece, so there are restrictions on the power of the product.

3.7 Select Results

Since the design goal of this product is to convey the humidity level of indoor air by means of dynamic design, the product needs to be able to all regulate the air in at least one room of 20 square meters of space, and the power requirement of the product needs to be at least 30W, so the author cannot choose a desktop humidifier or a micro humidifier, because these humidifiers can only affect a small area of 1-2 square meters of space. On the other hand, compared with the way of adding water under, the humidifier with water on top has the characteristics of simple structure and easy operation, so in summary, the author decided to use the humidifier with water on top structure as the basic reference object and redesign on this basis.

Image 39.
Humidifier with Top-Fill Water Structure
https://www.vyixuan.com/detail/jddata748/100005786478

Image 40.
Humidifier with Lower Water Filling Structure
https://www.midea.cn/10070.html?mtag40003.7.10070

Image 41.
Desktop Humidifier
https://www.toodaylab.com/76164

Image 42.
Mini Humidifier
https://www.zhihu.com/question/450956765

3.8 Case Study

3.8.1 Product Introduction

After a preliminary study of the basic structure of ultrasonic humidifier and the way it works, I will experience the actual operation of a humidifier and disassemble the humidifier. The purpose is to personally understand the use process and experience of the ultrasonic humidifier in the process of use, and to have a more in-depth understanding of the basic structure, assembly method, materials, processes and types of components of the humidifier in the process of disassembly, so as to provide a solid experience and theoretical basis for the subsequent innovative design of the humidifier.

The following is a brief introduction of the product name, basic functions and parameters.
Reference Product: Mijia Smart Germicidal Humidifier S

Basic function:
Turn On/Off
Fog volume adjustment
Constant humidity control
Water shortage warning
Displacement warning for water tank

Basic parameters:

Rated voltage/frequency	220V-50HZ
Water tank capacity	4.5L
Product net weight	2.1kg
Product size	190*190*353mm
Product model	MJJSQ03DY
Rated power	40W
Humidification rate	450ml/h
Working noise	≤39dB

Image 43.
Reference Product
https://www.robotworld.cz/zvlhcovace-vzduchu

3.8.2 Analysis of Usage Process

1. Position the humidifier in the correct position and connect the power.

2. Open the top cover and add water directly to the water tank.

3. Close the cover in the correct position.

4. Start the humidifier and adjust the humidifier power continuously.

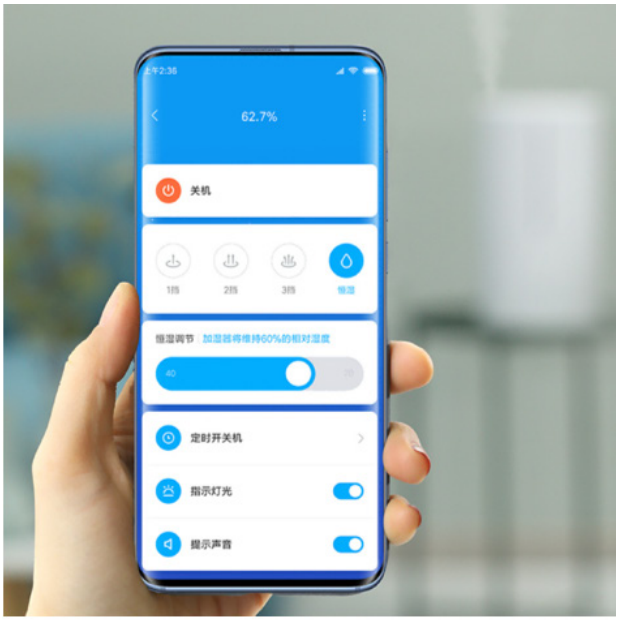
5. The button on the back of the humidifier can activate the night light.

6. If you pick up the water tank, the humidifier will stop working and the indicator will be red.

7. When the water runs out, the indicator light also turns red and stops working.

8. At this point the lid should be opened and water should be refilled.

9. Press and hold the button on the back for three seconds to activate the Bluetooth function and connect to the phone.



10. The humidifier can be operated remotely on the mobile phone interface.

3.8.3 Disassembly of Product And Analysis of Components

The main part of the product is mainly divided into Lower part, water tank and lid. The Lower part mainly integrates the main functions of the product and all components. The Water tank is the area where the product stores water and circulates mist. Lid used to close the water tank while the product is in operation.
Except for the internal components, the main body of the product is almost entirely made of ABS plastic through injection molding.

Image 44.
The main part of the product

(1) Lower Part
The structure of the lower part includes the main body and the lower cover.
All components are also fixed inside the main body with screws or plugs.
Connection method: screw, glue
Material: ABS
Manufacturing Process: Injection Molding

Analysis of the functional partitioning of the surface of the Lower part
① Trigger: Push the valve of the sink to allow water to flow to the space below.
② UV Lamp: The water continues to flow around the UV lamp, removing bacteria from the water.
③ Atomizer: Atomizer vibrates at high frequency to disperse water molecules.

④ Water level measuring device: suspend work and give an alarm when there is water shortage.
⑤ Air outlet: driven by the internal fan to accelerate the air flow and discharge the mist.
⑥ Night light: Used to provide night lighting and ambient lighting.

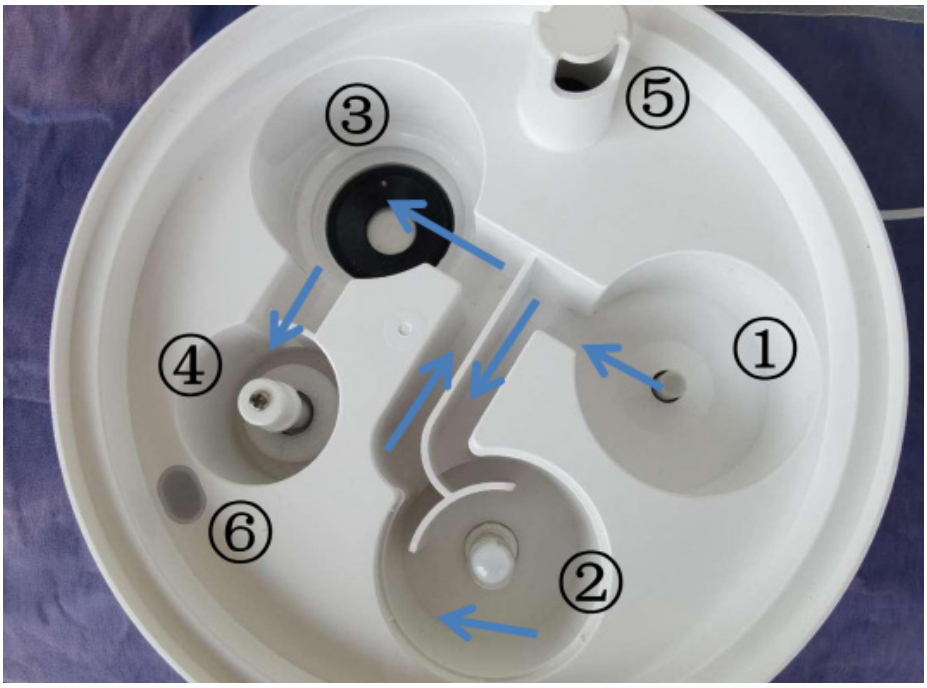


Image 45-46.
Lower Part

Image 47-48.
Detail of ring float

Image 49.
Lower Lid

Details of ④
The interior includes a buoyancy ring with magnets. When there is a shortage of water, the ring goes down, triggering a switch inside that stops the humidifier from working.

Lower Lid
The main functional parts of the lower cover include
① Screw column: Used to connect and fix with the main body of the lower part.
② Filter cotton: used for preliminary filtering of the air entering the humidifier.
③ Fixed area of wires: Used to arrange and fix the wires of the internal components of the humidifier in a reasonable way.

Details of ②

The filter cotton is fixed around the lower cover with glue and seals the holes around it, so as to filter the air flowing into the humidifier.

Internal Components

① Atomizer: The atomizing piece vibrates rapidly to separate the water in the lower part into fine particles.

② Fan: Provide air flow, and discharge the fog into the air actively, so as to improve the humidifying range.

③ Humidity sensor: for constant humidity, humidity control and other functions.

④ Trigger mechanism: When the lower part is short of water, the trigger will actively move upward to open the valve of the water tank so that the water will flow into the lower part.

⑤ UV lamp: to be atomized water for deep disinfection and sterilization treatment.

⑥ PCB: The electronic control center of the humidifier.

⑦ Plug: provide electric power for the humidifier.

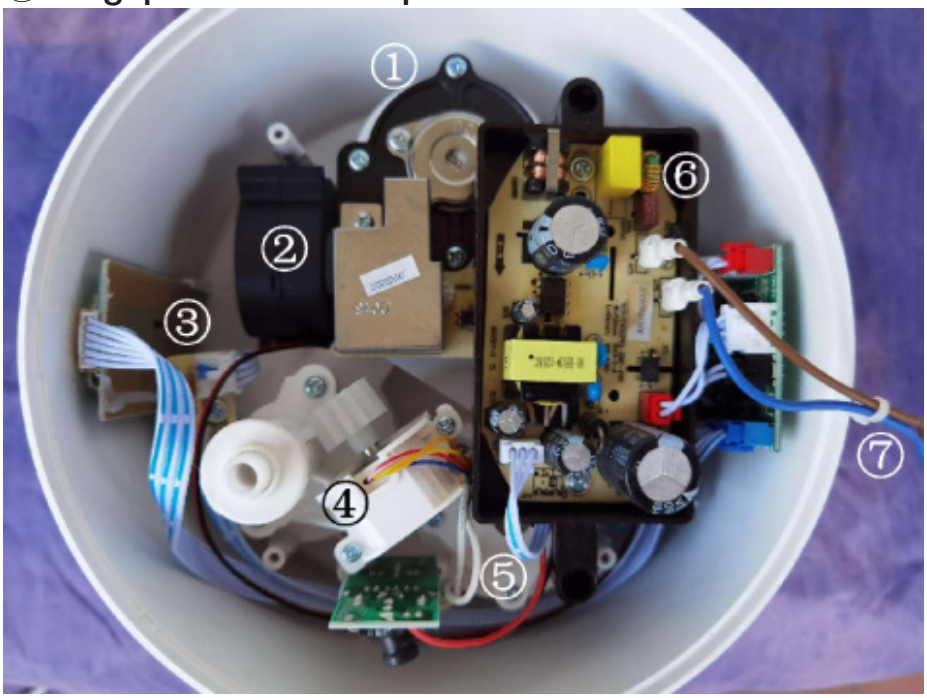


Image 50-51.
Details of lower lid

Image 52.
Internal Components

(2) Water Tank
This part of the user stores the water needed by the humidifier and contains pipes through which the mist circulates.

Connection method: snap fit,ultrasonic welding
Material: ABS
Manufacturing Process: Injection Molding

Functional Area
① Mist outlet: The mist produced by the atomizer passes through here and is then delivered to the air.
② Valve: The valve is controlled by the trigger and is used to control the flow of water from the lower part of the tank.
③ Positioning means: Used to limit the position of the water tank when it is placed in the lower part.
④ Location of night lights: This is a piece of translucent plastic that allows night lights to pass through it and then shine into the inside of the tank.
⑤ Water tank position sensor: It contains a magnet to sense the connection between the tank and the lower part.
⑥ Water Level window: The window for viewing the water level.
⑦ Outlet pipe: The pipe from which the user mist is exhausted.

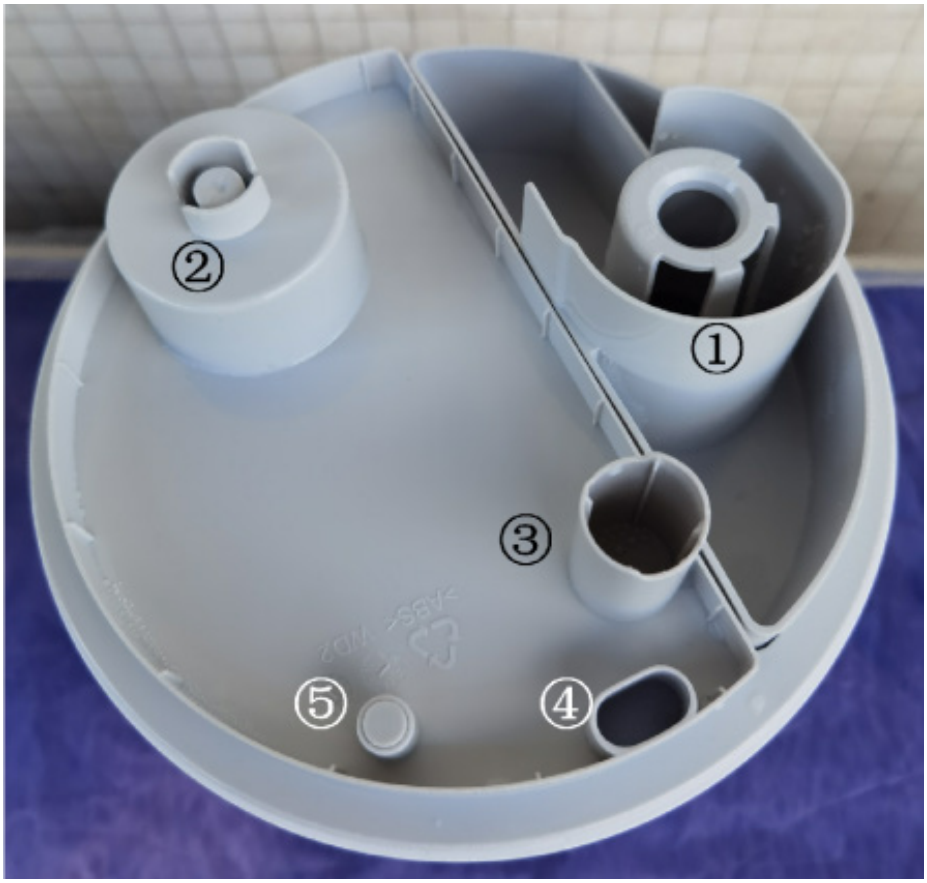
Details of ⑤
Water tank position sensor
The main structure consists of a rubber sleeve containing a magnet, which is fixed at the lower part of the water tank.
When the user puts the water tank on the base of the humidifier according to the correct position, the magnet will trigger the switch of the internal components of the base to make the humidifier work normally. .
When the user removes the tank, the magnet disengages from the internal components, causing the switch to open, causing the humidifier to stop working.

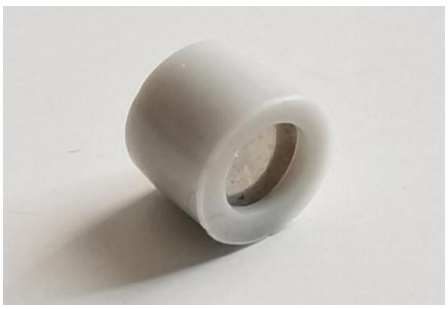
Image 53.
Functional Area

Image 54.
Water Level window

Image 55.
Outlet pipe

Image 56-57.
Details of water tank position sensor





4. Product Concept Generation

4.1 Brief

4.1.1 Availability

The author's design goal is first of all an ultrasonic humidifier redesign. Therefore, the product must have the basic function and use effect of a humidifier. The humidification principle, material selection, process selection, and basic structure largely follow the style of ultrasonic humidifier, and innovative design is carried out on this basis. On the other hand, due to the limitations of the product power as well as volume, the effective humidification range of the product should not be too large, and the effective humidification range is expected to be between 20 square meters - 30 square meters, which is a bedroom space.

4.1.2 Incorporation of Dynamic Design

The product satisfies the basic functions of a humidifier on the basis of the need to apply the methodology of dynamic design mentioned earlier. The use of dynamic symbols in terms of five senses instead of traditional numerical symbols to convey information about air humidity or product status, thus allowing users to more clearly and actively understand the current air humidity information.

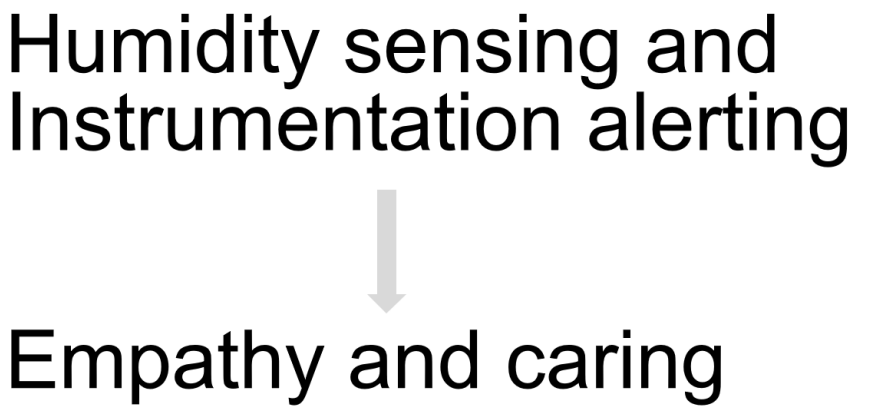
4.1.3 Impact on User Behavior

The product takes advantage of dynamic design to convey information clearly and urgently, so that users can quickly and accurately grasp the state of the air and actively use the humidifier to adjust, rather than mechanically and passively follow the use of the product. Also because of this, the user still retains sufficient freedom of use and control over the product, but can continue to use the product under the influence and induction of the product, and thus develop good habits.

Image 58.
Change of user's motivation to use

4.1.4 Integration of Semiotics

The author explores the product as an emotional design, in order to change the user's behavior in an instinctive way, it is necessary to emotionally evoke the user's inner resonance. Therefore, the product should be combined with some kind of semantic symbols on top of the information conveyed by the dynamic design, and have some kind of symbolic meaning of humidity change, so as to evoke the user's past experience and make the user interact and resonate with the product emotionally. Transfer the user's motivation for using the humidifier from the weak perception of air humidity to empathy and care for the humidifier itself.



4.1.5 Integration with Semiotics

According to the previous description, the product needs to have certain symbolic semantics to evoke the emotional resonance of the user, so the appearance of the product needs to have a certain degree of similarity with air humidity related items, but this similarity can only be imitated in its abstract form and symbols, rather than simply copying its concrete form. On the other hand, while the product has other symbolic symbols, it needs to still have the recognition as an indoor humidification product, so that users can understand its function from its appearance.

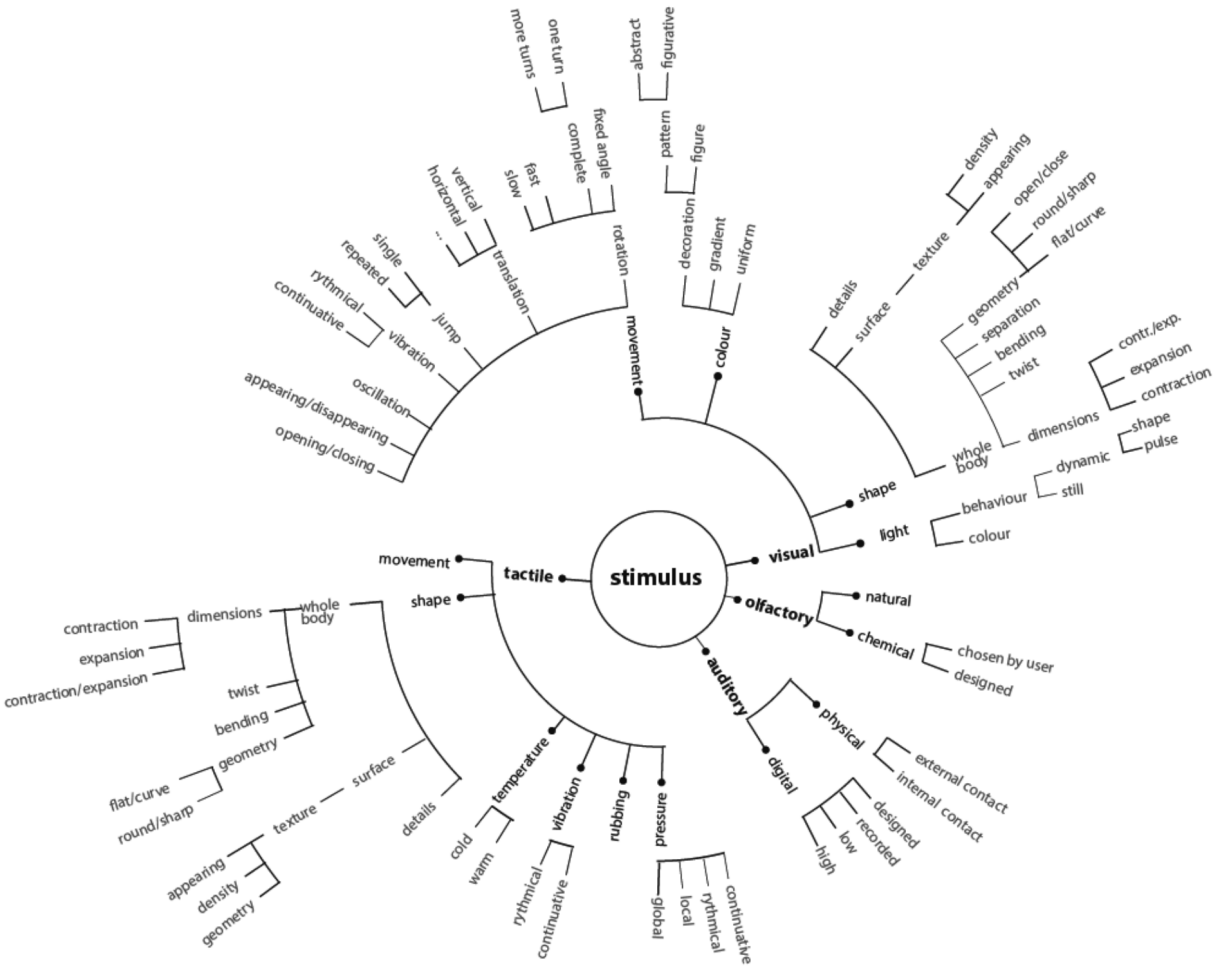
4.1.6 Symbiosis

The dynamic parts of the product as well as the symbolic parts of the symbol cannot completely override the humidifier and thus appear not to be convincingly present. This means that the part should also have a certain utility while conveying dynamic information and symbolic meaning, so that the symbolism and utility of the product can be symbiotic on the same part.

Image 59.
Selection of Dynamic Sensory Modalities
González-Colominas, Marta. 'Dynamic Experiences Generated by Sensory Features through Smart Material Driven Design'. Temes de Disseny, no. 34 (26 November 2018): 48–59. https://doi.org/10.46467/TdD34.2018.48-59.

4.2 Selection of Dynamic Sensory Modalities

The author researched a project report from ELISAVA, which consisted of ten sub-projects and was divided into five teams, developed by ELISAVA students over the last three years to improve the implementation of the methodology. They analyzed and explored ten different cases of dynamic design, all of which also contained unused five-sensory ways of communicating information in dynamic design. At the end of the project, a sensory map was created to clearly represent the number and range of different sensory design approaches.
The results highlighted that sight is the most employed sense to design dynamic experiences. Sight is our dominant sensory system, which collects nearly 80% of human beings' sensorial impressions.



4.3 Choice of Behavioral Induction Methods

As mentioned earlier, deterministic and coercive approaches are undoubtedly the most effective, but they can also lead to a not-so-good user experience, because such approaches mechanically prescribe or constrain the user's right to choose and regulate foundational and necessary needs.

Seductive and persuasive approaches, on the other hand, are only weakly influential, but they create and maintain a good user experience because they create cognitive and emotional changes and leave users with sufficient choice. These two methods are also used in the opposite scenario to the deterministic and coercive approaches, applied to social and humanistic needs, both even if the user's own choice of other ways of behavior is harmless and has no serious consequences.

To sum up, since the use of humidifiers belongs to the category of healthy living and is an experiential product based on the satisfaction of basic and necessary needs, the author decided to use seductive or persuasive approaches to change user behavior, rather than coercively restraining the user's behavior.

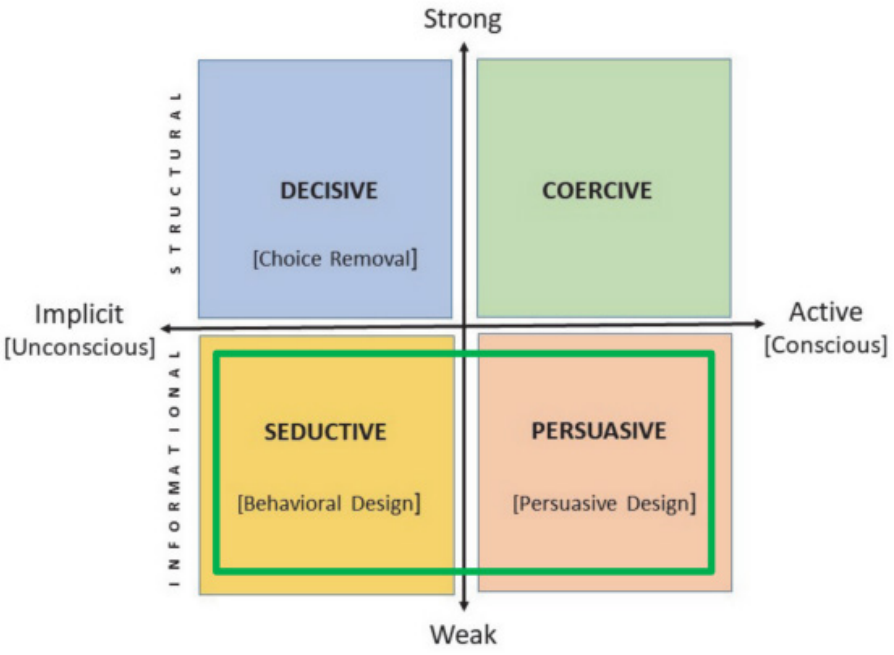


Image 60.
Seductive and persuasive approaches
Colombo, Sara, Roberto Gorno, and Sara Bergamaschi. 'ENHANCING PRODUCT SENSORY EXPERIENCE: CULTURAL TOOLS FOR DESIGN EDUCATION', 2013, 6.

4.4 Limitations of The Design

4.4.1 Structural Limitations

The product is mainly divided into an upper part and a lower part. The upper part consists of a water tank and pipes fixed inside the water tank. There is a valve on the top of the water tank, which is responsible for letting the water flow to the lower part.
The lower part of the area is divided into two parts, the area located in the upper part is the water treatment area, which is mainly responsible for atomizing the water flowing out of the water tank, and then removing the mist from the pipeline. The space in the lower volume is responsible for installing all the components of the product, and the interface is also located on the side of the lower half.
If you want to re-design the humidifier, you need to use the above basic structure and functional blocks as the foundation, and transform and re -design the product in a limited space and freedom.

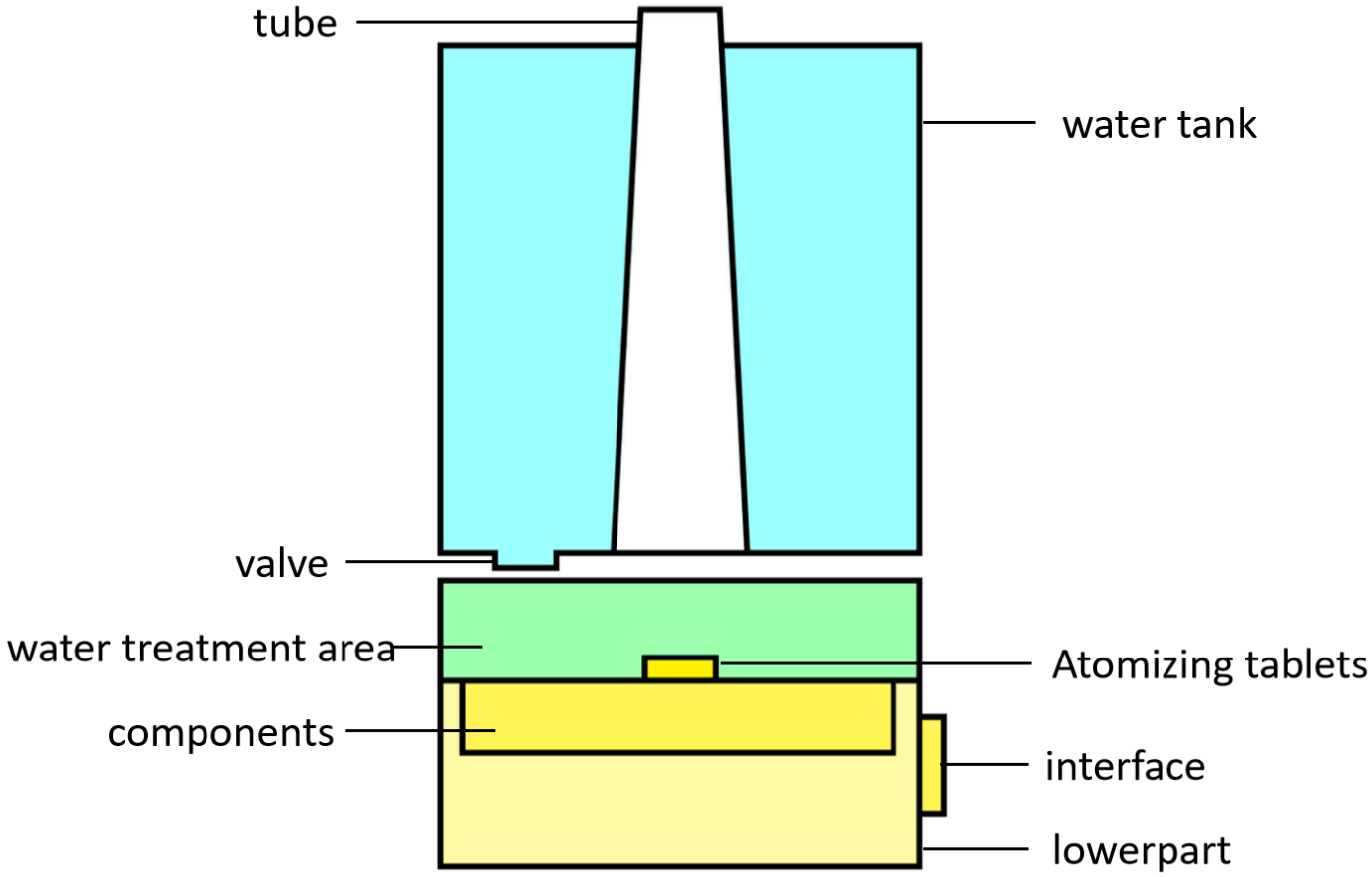


Image 61.
The basic structure sketch of ultrasonic humidifier

What We Can Not Change

The types of the main functional modules of the humidifier, including the basic structure of the water tank, pipes, and lower parts, cannot be changed, otherwise the basic functional requirements of the product cannot be met.
On the other hand, the main structure of the product and the positions between the modules cannot be changed.

What Are Our Freedoms

The types of the main functional modules of the humidifier, including the basic structure of the water tank, pipes, and lower parts, cannot be changed, otherwise the basic functional requirements of the product cannot be met. On the other hand, the main structure of the product and the relative positions between the modules cannot be changed.
The relative position of each functional block can be slightly adjusted, for example, the pipe can be located in the center of the water tank, or on the inner side of the water tank.

The Way of Redesign

The authors want to combine dynamic design with humidifiers while demonstrating the functional necessity of dynamic components.
Therefore, the author believes that the dynamic design of the original parts of the humidifier should be modified, rather than adding additional parts to demonstrate the dynamic design. According to the previous structural analysis, the author believes that the transformation can be carried out from the relationship between the water tank and the pipeline, because the two parts have a large degree of freedom, allowing designers to carry out dynamic design and even reference imagery.

The freedom of the upper part is mainly reflected in the relative position and shape of the water tank and the pipe, because the change of this part will not affect the function of the humidifier, and can be redesigned on the basis of fully considering the manufacturing process and cost.

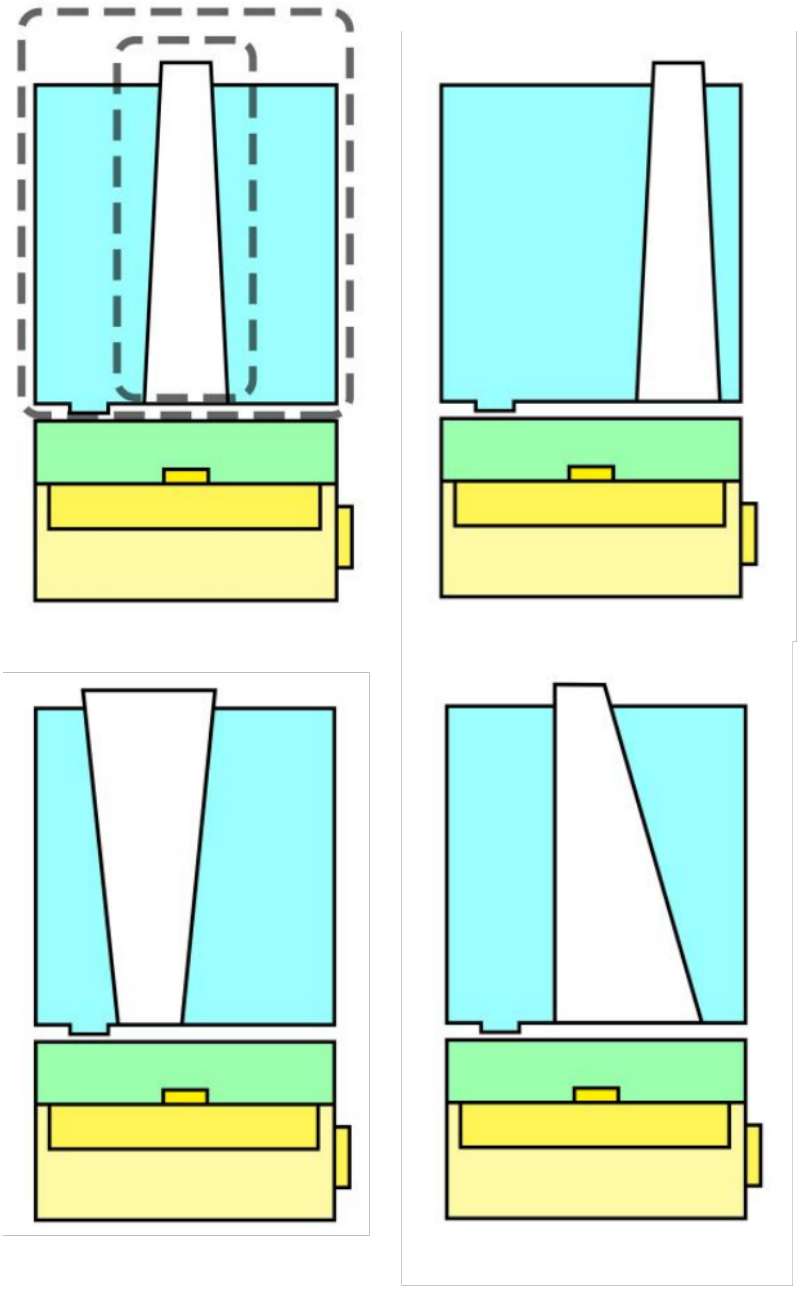


Image 62-65.
The freedom of redesign

4.4.2 Summary of Key Point

According to the basic structure and functional block analysis of the product, the whole ultrasonic humidifier is a longitudinal structure, and the main power and components are distributed in the lower part. Therefore, in order to carry out dynamic design transformation of the product, its mechanical structure and power components should also be arranged in the lower part.

According to material research, the main material of most humidifiers is ABS plastic.Therefore, the abstract form of the selected image should basically meet the processing technology of plastic.

After estimating the volume of the water tank according to the functional goals to be achieved by the product, it is known that the volume of the product water tank is about 2.08L, which can limit the overall volume of the product, and the lower part and the dynamic design mechanism to be added in the future must also be based on this volume.

Image 66.
The main power and components are distributed in the lower part

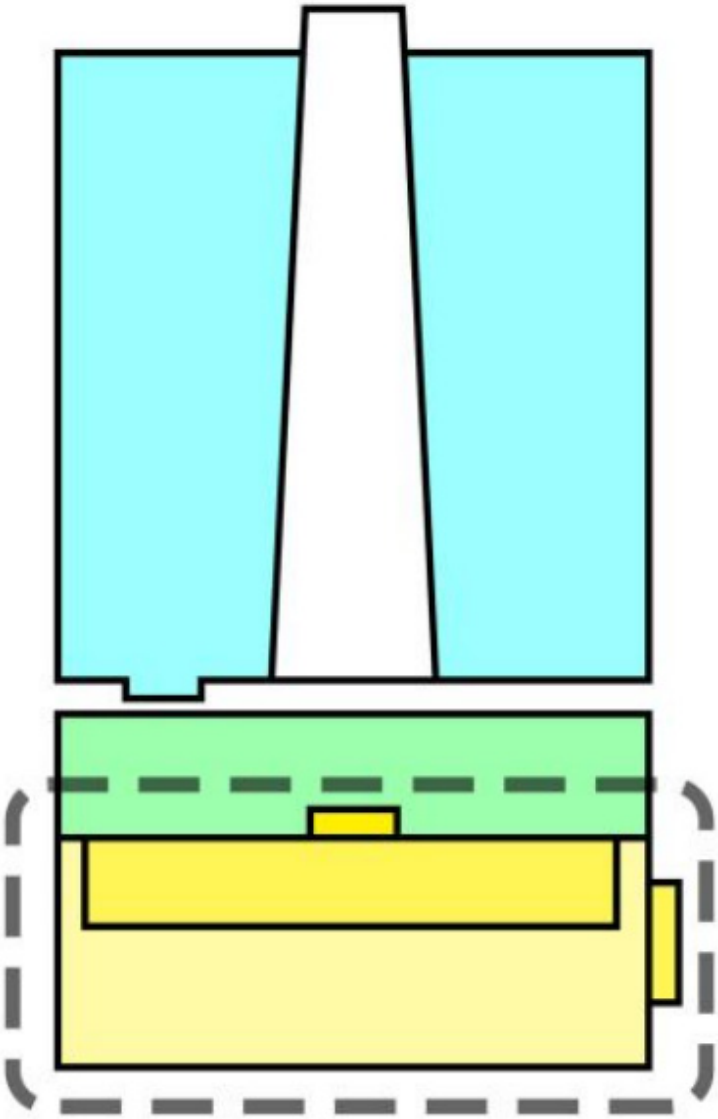
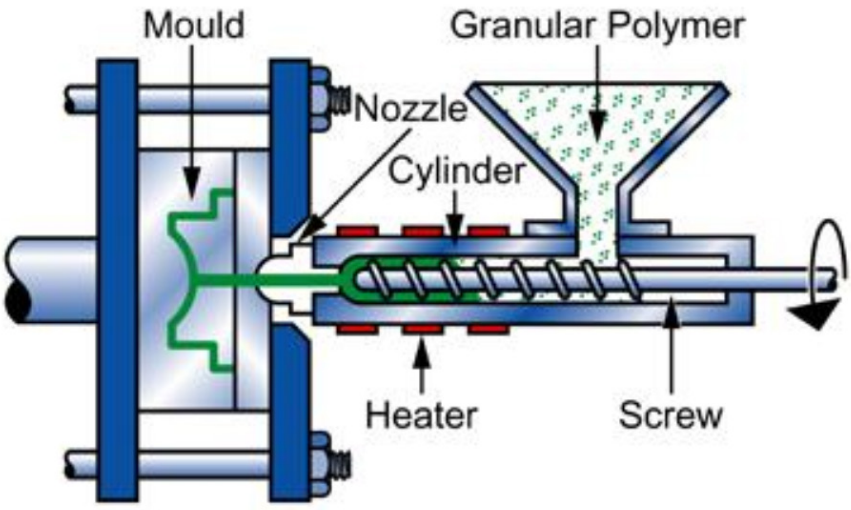


Image 67.
The processing technology of plastic
https://www.sohu.com/a/341513386_505824



4.5 Selection of Product Imagery Symbols

4.5.1 Case Study

Before making the imagery selection for the humidifier, the author needs to research some existing cases that use the semantics of the product form and draw out the points to note from them.

(1) Oblio, a device for disinfecting and charging smartphones.
The wireless charging station designed in the shape of a vase can discreetly kill harmful viruses and bacteria. The form of the vase fulfills the function of charging and disinfecting cell phones, but also serves as a decorative landscape for the interior, blending perfectly with the user's usage environment.

Image 68-69.
Oblio, a device for disinfecting and charging smartphones.
https://lexon-design.com/us/product/oblio/

(2) Contactless Door Opening And Key Ring

Antibacterial silicone stylus tip, button pushers can be used for: lifting or ATM button press, opening and closing tap water, switching light buttons, sliding doors, etc. Resistant finger holes with built-in hooks can be easily clipped on the user's key ring. The overall shape of the product also resembles an abstract key. The various protruding structures on the key can help the user to complete various actions, on the other hand the shape of the key can also establish a connection with the combination of the product and the key ring.

Image 70-73.
Contactless Door Opening And Key Ring
https://lexon-design.com/en/product/horizon-safetouch/

(3) A must-have accessory for your desktop, the Peas Hub 2 is a multi-port hub (2 USB-C and 2 USB-A) that allows you to connect up to 4 devices at the same time. Thanks to its different types of ports, Peas Hub 2 is compatible with the latest and previous generation peripherals such as cables, keyboards, mice or flash drives. The form of the product resembles a pea. Using this semantic communication both makes the product interesting and effectively divides the different kinds of interface areas on the product to help users understand and use it.

Image 74.
Peas Hub 2
https://www.uniqshop.net/lexon-peas-hub-2-usb-cogaltici---koyu-gri-29762

(4)Wake up Gently with Miami Sunrise.

This alarm clock gradually simulates the sunrise to wake you gently with a natural and pleasant brightness. This sleek and modern design also offers a choice of over 6 natural sounds, as well as touch control to adjust lighting and snooze function. With Miami Sunrise, you'll have no trouble starting your day off right.And the round shape of the product resembles the newly risen sun, which builds a good internal connection with the function of the product.

Image 75.
Miami Sunrise
https://lexon-design.com/produit/miami-sunrise/

(5) "Complete sound on the move" best describes the beautiful and powerful portable Bluetooth speaker Lexon LA95 Hoop, which has the unique shape and size of a doughnut and is perfect for the user's lifestyle, allowing music to be enjoyed both indoors and outdoors. It was designed by Italian duo Valentina Del Ciotto and Simone Spalvieri and was awarded the prestigious Red Dot Design Award in 2015 as a winner.
Music can be streamed from any Bluetooth device (e.g. iPhone, smartphone, etc.). The speaker is also equipped with a hands-free function for phone calls and the volume is controlled by a touch sensor button on the back. The device charges when connected to a computer or battery pack via the included USB cable. Cleverly, it can be mounted on the wall using the included rubber plug, or hung anywhere else with a rubber cord (also included).

Image 76.
Bluetooth speaker Lexon LA95 Hoop
https://www.pinterest.fr/0xq9bfdfkbesyur/

4.5.2 Summary of Key Points

Based on case studies and related literature, the author summarizes the main points that should be noted when using semantic symbols for product shape.

(1) How the product shape including size, material, color and form can be harmonized with the surrounding environment.

(2) Even if the product itself is combined with the chosen imagery, it should retain sufficient recognition of the product's original function, which can allow users to judge how the product is used and how it functions based on its general shape.

(3) The choice of semantic symbols should be intrinsically linked to the function of the product, the environment of use or the way of use, creating the intrinsic value of the product, suggesting the cultural connotation and symbolic meaning of the product, so that the form of the product will not be completely separated from its function.

(4) The semantic form of the product should preferably convey its intrinsic value while also having a certain functionality that can help users better understand or use the product.

4.5.3 Criteria for Selection of Imagery

As mentioned above, the appearance of the product needs to be combined with the morphological symbols of some other objects. And I think this morphological symbol needs to meet the following two points at the same time:

First, this imagery should be dynamic, rather than static and unchanging, so that this feature can be used for subsequent dynamic design;

Second, in the symbol must have a close association with the change of air humidity, and this association is widely known, so that the user can unconsciously see the product when Associated with the state of air humidity, thus evoking the user's past experience from the user's psychological instinct level, and the user's behavior to induce and influence;

Third, the imagery of the product form must be able to meet the original function and structure of the humidifier to achieve, including the humidifier functional blocks, materials, manufacturing processes;

Fourth, because the product uses the concept of symbiosis, expressing the user's empathy and care for the product, the choice of product imagery should also be an organic life form, so it is conducive to evoking empathy.

4.5.4 Selected Imagery Symbols

In summary, the author decided to start with the shape and structural relationship between the pipeline and the water tank. Combining the needs of product structure and dynamic design and imagery,and it needs to be an organic life form as imagery, so the author decided to imitate the shape of flowers and plants as the upper part of the humidifier, use the relatively regular shape of flowers and plants as the entrance of pouring water, and use it as a dynamic design component to convey imagery and change in air humidity.

Image 77.
The imagery of flowers and plants
https://www.pinterest.it/

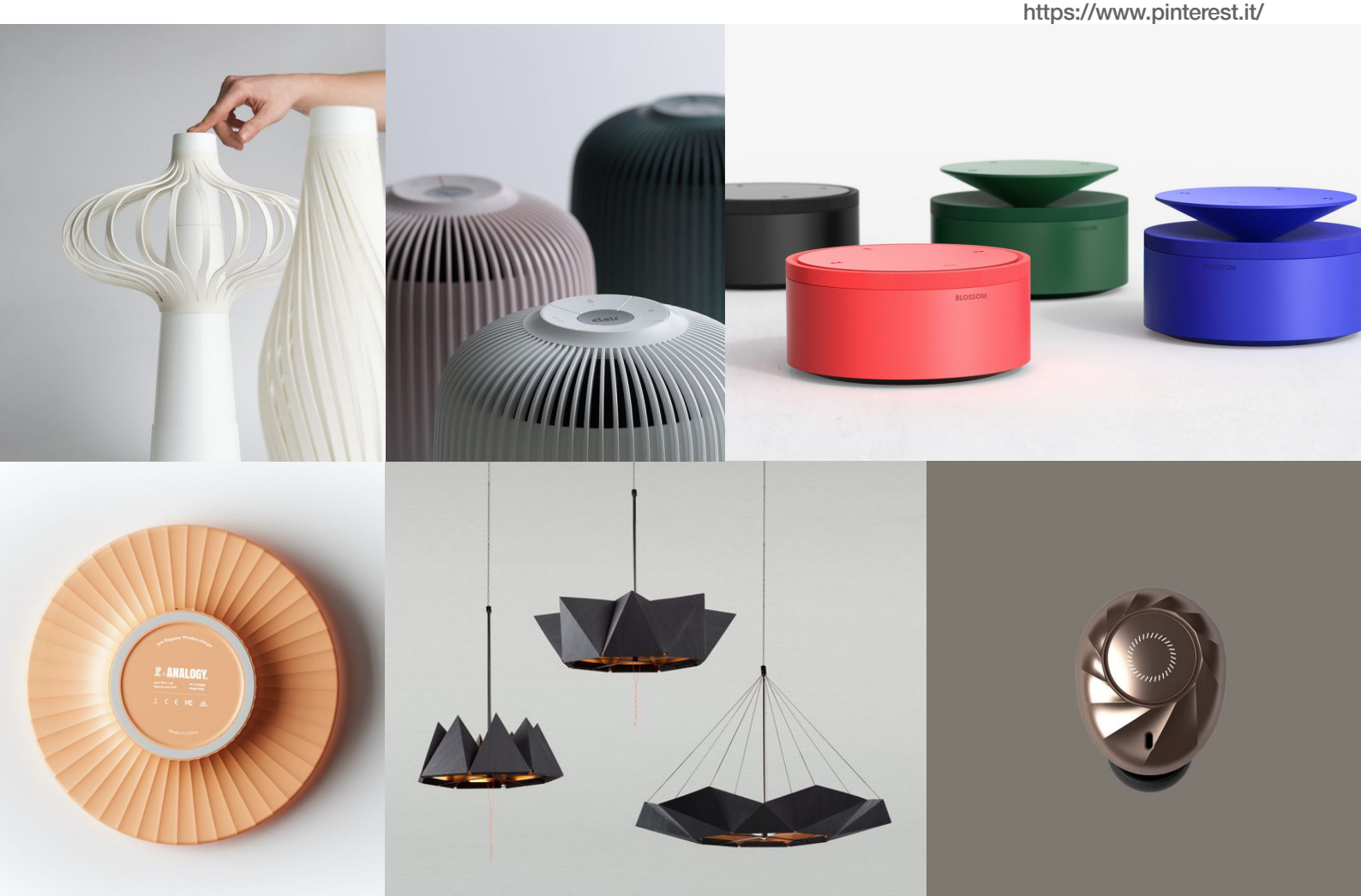
4.5.5 Moodboad

At the top of the humidifier, there is a flower or plant as shown in the figure, which can change its height with the change of air humidity, so as to present an unfolded and closed shape with the main body of the humidifier.

The appearance of the product should be simple, modern and soft, and present some organic forms so that it can adapt to the interior decoration environment that is not used.

This widget has four functions:
1. The shape of the funnel is convenient for users to add water directly from above
2. Imagery of flower morphology and dynamic changes
3. Convey air humidity levels during dynamic changes
4.This part can be used as an operator interface, which means that the user can directly rotate the part to make humidifier adjustments.

Image 78-83.
Moodboad
https://www.pinterest.it/



5. Product Display

5.1 Design Concept

I named the design Symbiosis, which represents both the symbiosis of the product and the user in the same environment and mutual influence, and also represents the combination of organic imagery and function of the product itself. Finally it also encompasses the symbiosis between the aesthetic form of the product and the feasibility of engineering and manufacturing.

The product uses a growing flower plant as the imagery, expressing the product itself as an ultrasonic humidifier should have the basic humidification function, but also a symbiotic partner with the user, the product shows the state of the current environment and the state of the user.

The product links the state of its own imagery with the state of the user and the environment at the moment, and the product is no longer isolated from the user and the environment as an independent entity, but integrated into the user's use of the environment and psychological needs, so that the user treats the humidifier as a care for another organic life form, rather than a routine response to the instructions of the hygrometer.

Image 84.
Dry environment corresponds to wilted flowers
https://www.pinterest.it/

Image 85.
A moist environment corresponds to a flower in full bloom
https://unsplash.com/

5.2 Sketch

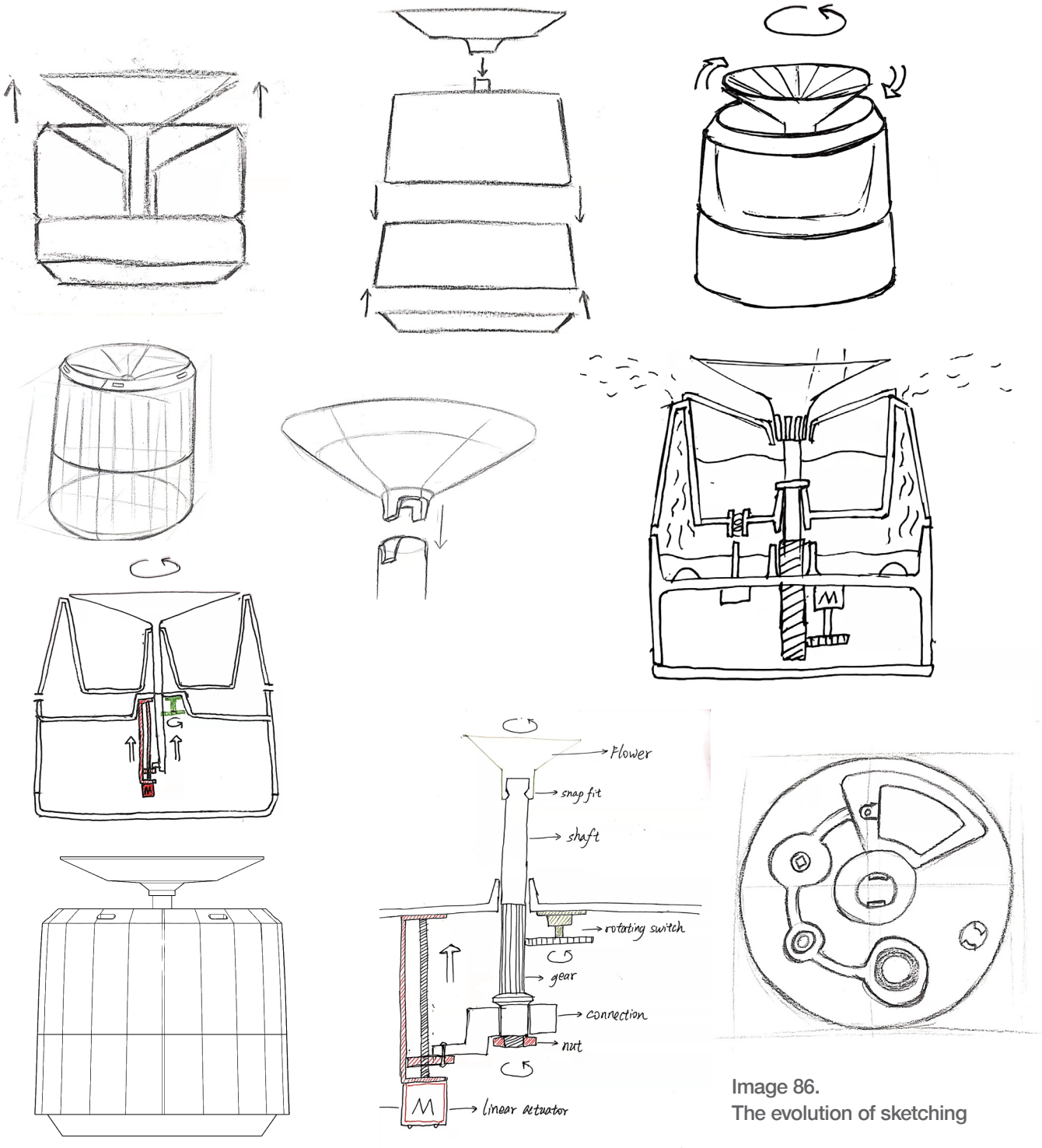


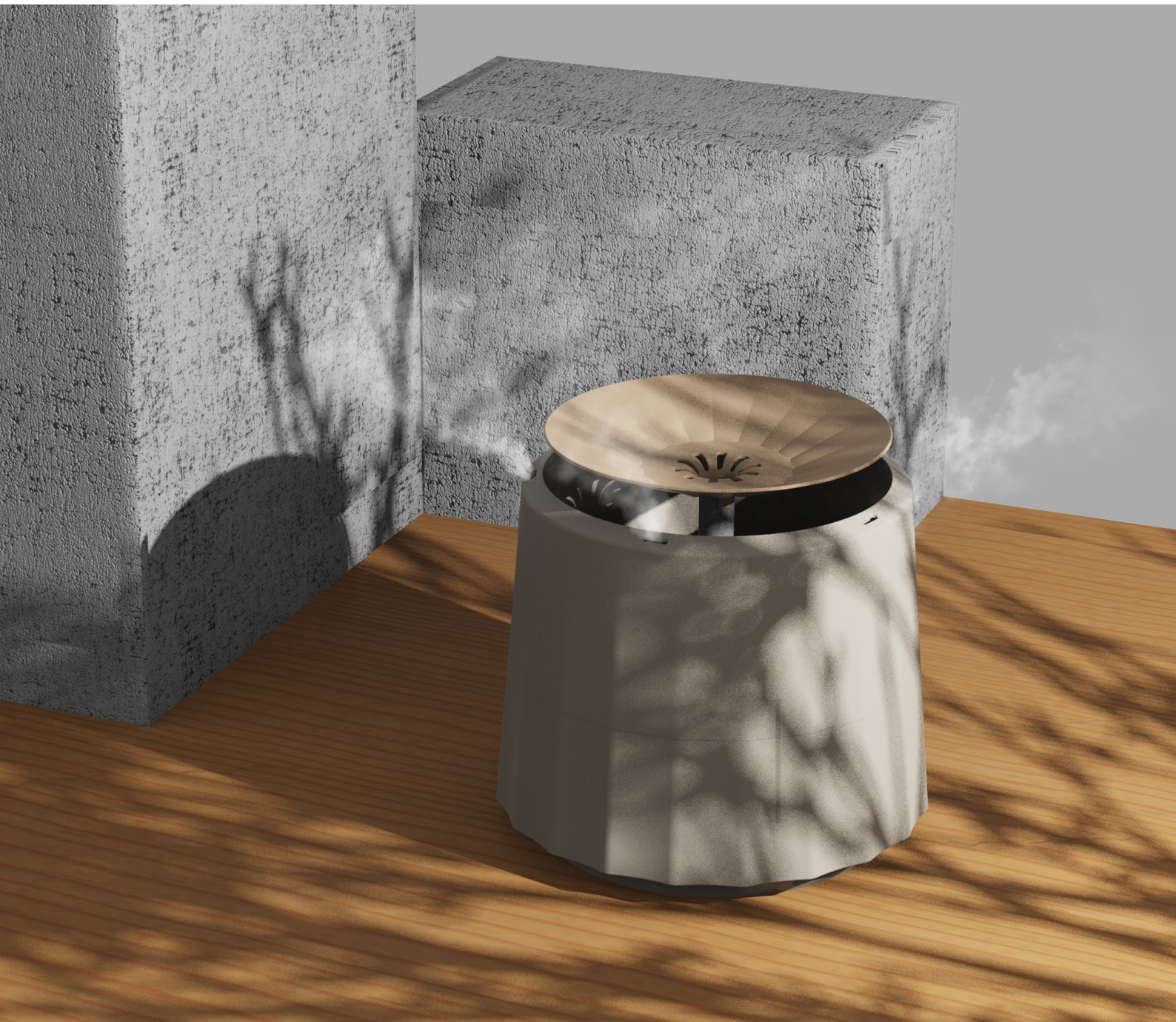
Image 86.
The evolution of sketching

The scheme of design sketch starts from the basic structure and function of the humidifier, finds the freedom belonging to the designer based on the feasibility of realizing the product, and explores the way of combining the humidifier with flowering plants on this basis, and finally finds the way of combining the humidifier with dynamic design.

5.3 Character

The humidifier uses floral plants as imagery and incorporates some vertical angles in its appearance, which mimics the organic form of the plants and can also increase the structural strength of the product. The use of low-saturation colors in the color makes the product fit better into different interior environments without looking abrupt.

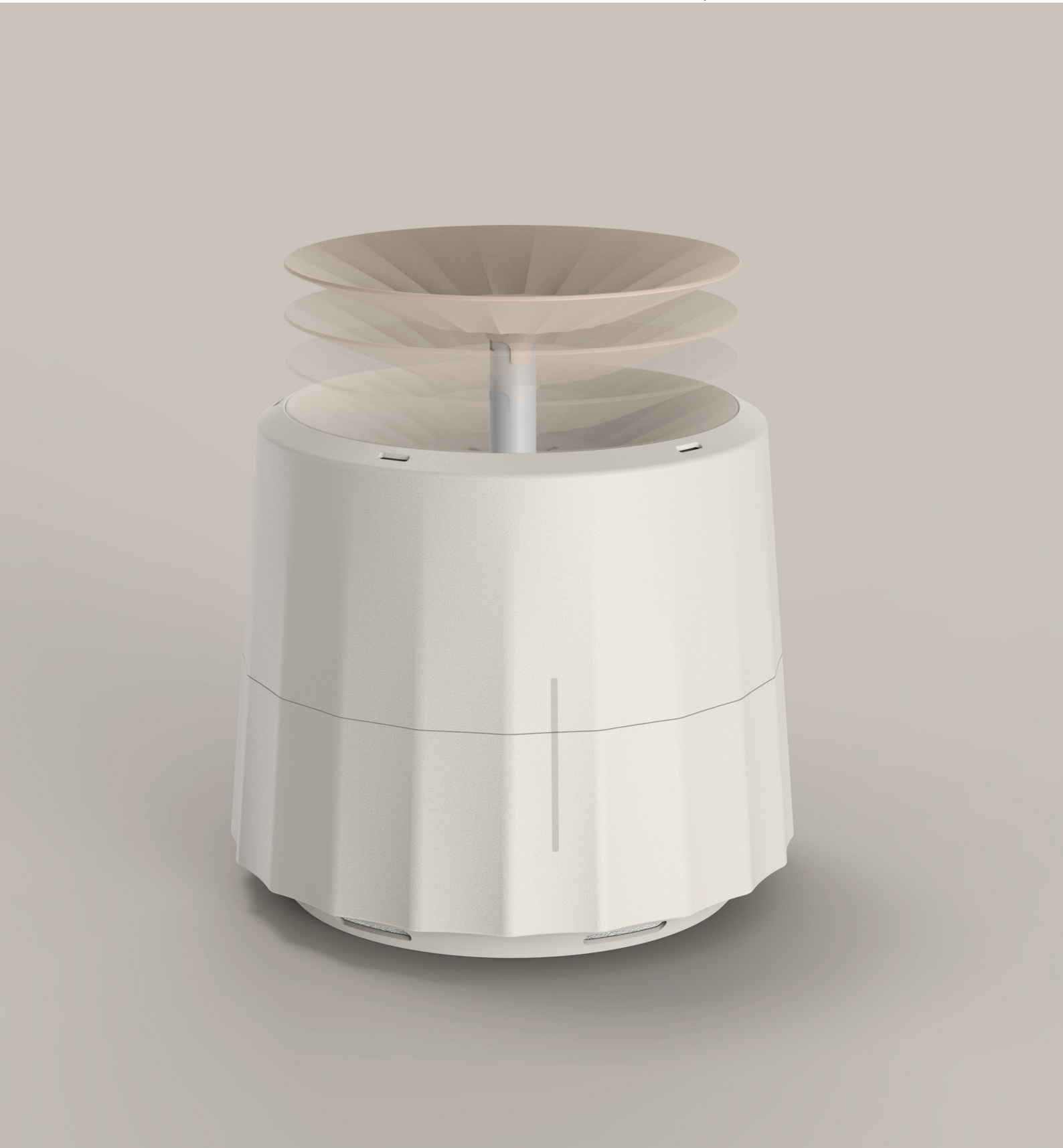
Image 87.
The character of humidifier



5.4 Working Method

The product uses flowering plants as imagery and combines the concept of dynamic design and behavior induction, combining the dynamic movement of flower with the current humidity of the air.

Image 88.
The process of raising the flower part



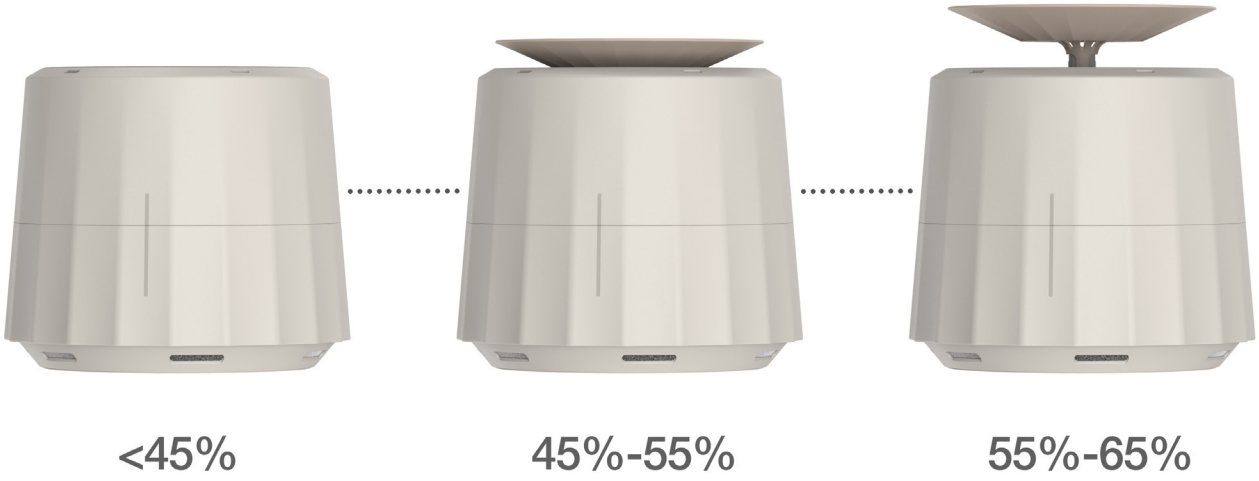


Image 89.
Different states of the humidifier correspond to different air humidity levels

When the air humidity is lower than the comfort zone, the flower on top of the product is controlled by the internal humidity sensor and retracted into the humidifier, thus using the current shape of the product state to convey air humidity information to the user, from the perspective of empathy to induce users to use the humidifier to make adjustments to the current air humidity. After that, as the air humidity gradually increases, the flower will gradually rise from the lowest point until it reaches the highest point indicating that the air humidity is sufficient, so that the user can always feel the change of air humidity brought by the humidifier from the visual aspect, as if the flower gradually grows and blooms. The figure below represents the change in the form of the humidifier at different air humidity levels.

On the other hand, the product meets the basic functions of ultrasonic humidifier, including atomization humidification, water shortage cut-off, UV disinfection, air filtration, etc.

5.5 Product Operation Process

5.5.1 Basic Operation Process

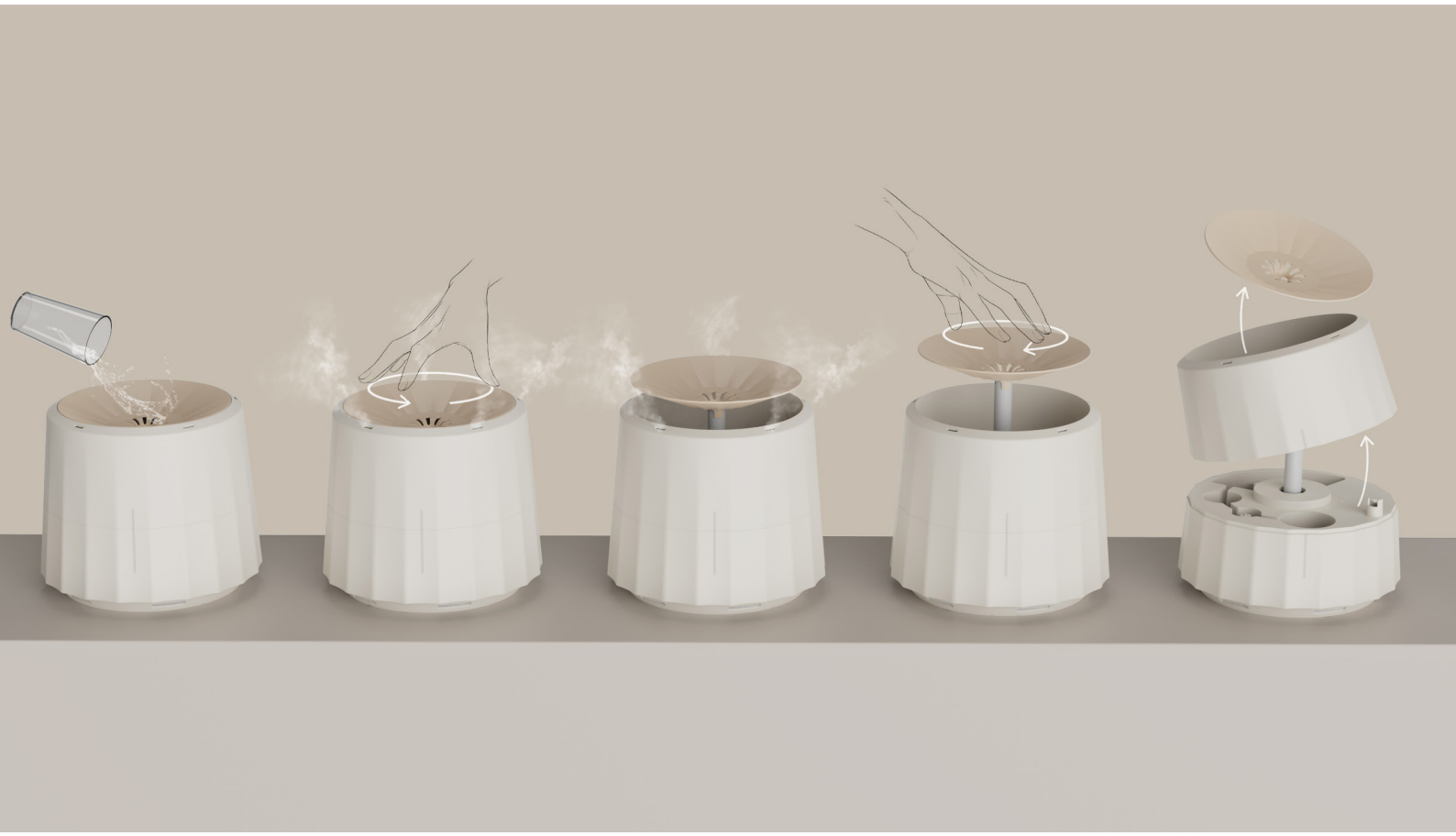


Image 90.
The process of using humidifier

1 When the air is relatively dry, the flower part retract into the interior of the humidifier. At this point the user can add water directly into the humidifier tank along the top of the humidifier. This step will be easily accomplished due to the special funnel shape of the flower part.
2 Used to turn the flower part counterclockwise by hand, you can start the humidifier and adjust the power of the oscillator. At this point the humidifier will emit mist to regulate the air humidity.
3 As the air humidity improves, the flower part is controlled by the humidity sensor inside the humidifier and gradually rises up to a height that reflects the current air humidity level.
4 When the air humidity is suitable, the user can turn the flower clockwise to reduce the amount of mist or turn off the humidifier.
5 Humidifier is used for a period of time, the user can easily disassemble the humidifier to clean it regularly.

5.5.2 Cleaning And Maintenance

The flexible snap fit connection between the flower parts and the shift makes it easy for the user to disassemble and install at any time.

Image 91.
Installation of flower part

When cleaning the humidifier, the humidifier can be easily disassembled into three parts: the flower parts, the water tank, and the base, and the internal surface is designed as a flat and regular shape, which is not easy to leave scale and easy to clean.

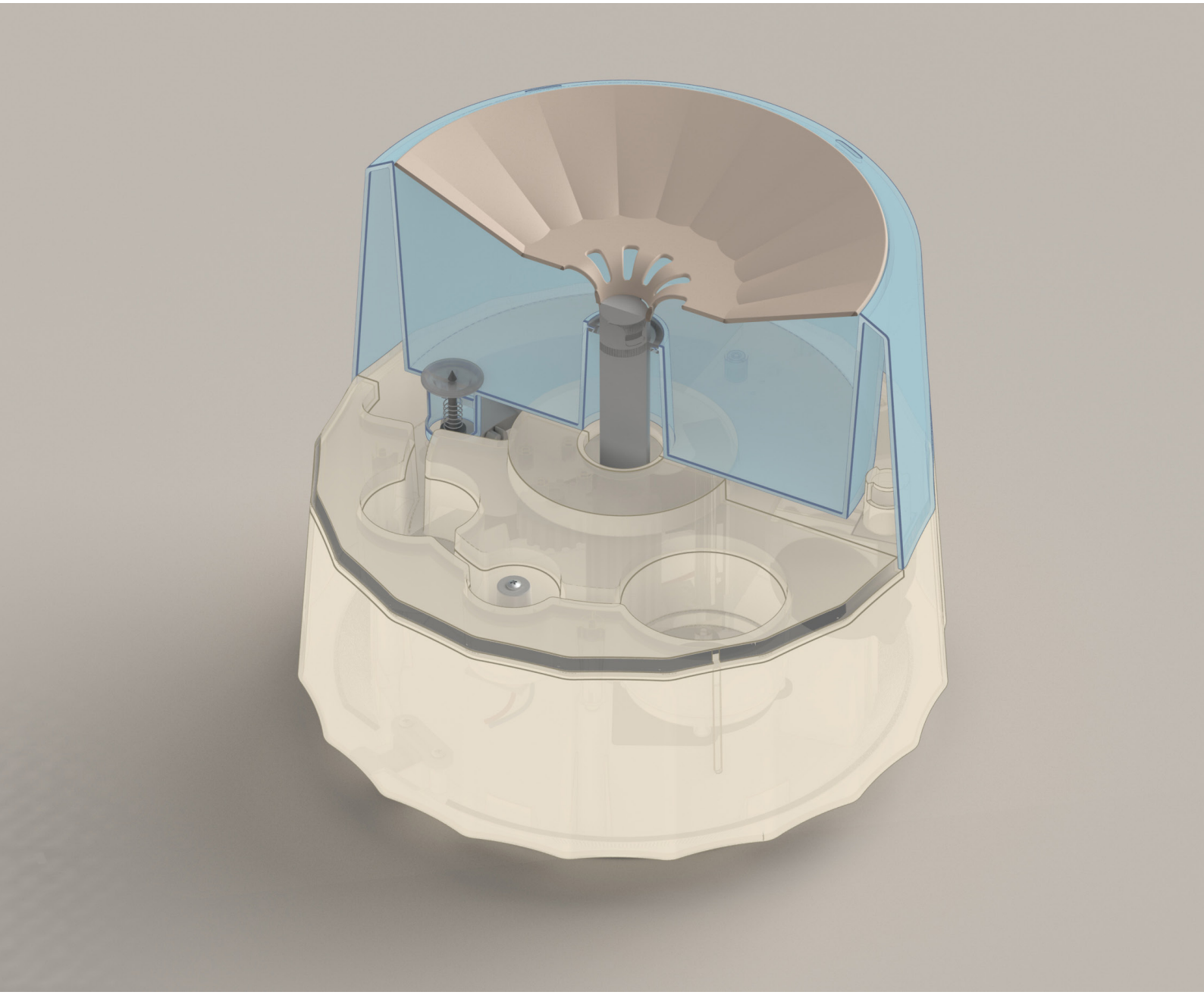
Image 92.
Humidifier cleaning and maintenance

5.6 Product Structure

5.6.1 Overall Structure

The humidifier body contains flower part, water tank, atomization function area and component area. Water flows into the atomization function area from inside the water tank and passes through each working module inside the function area one by one, so that water is gradually processed until mist is produced.

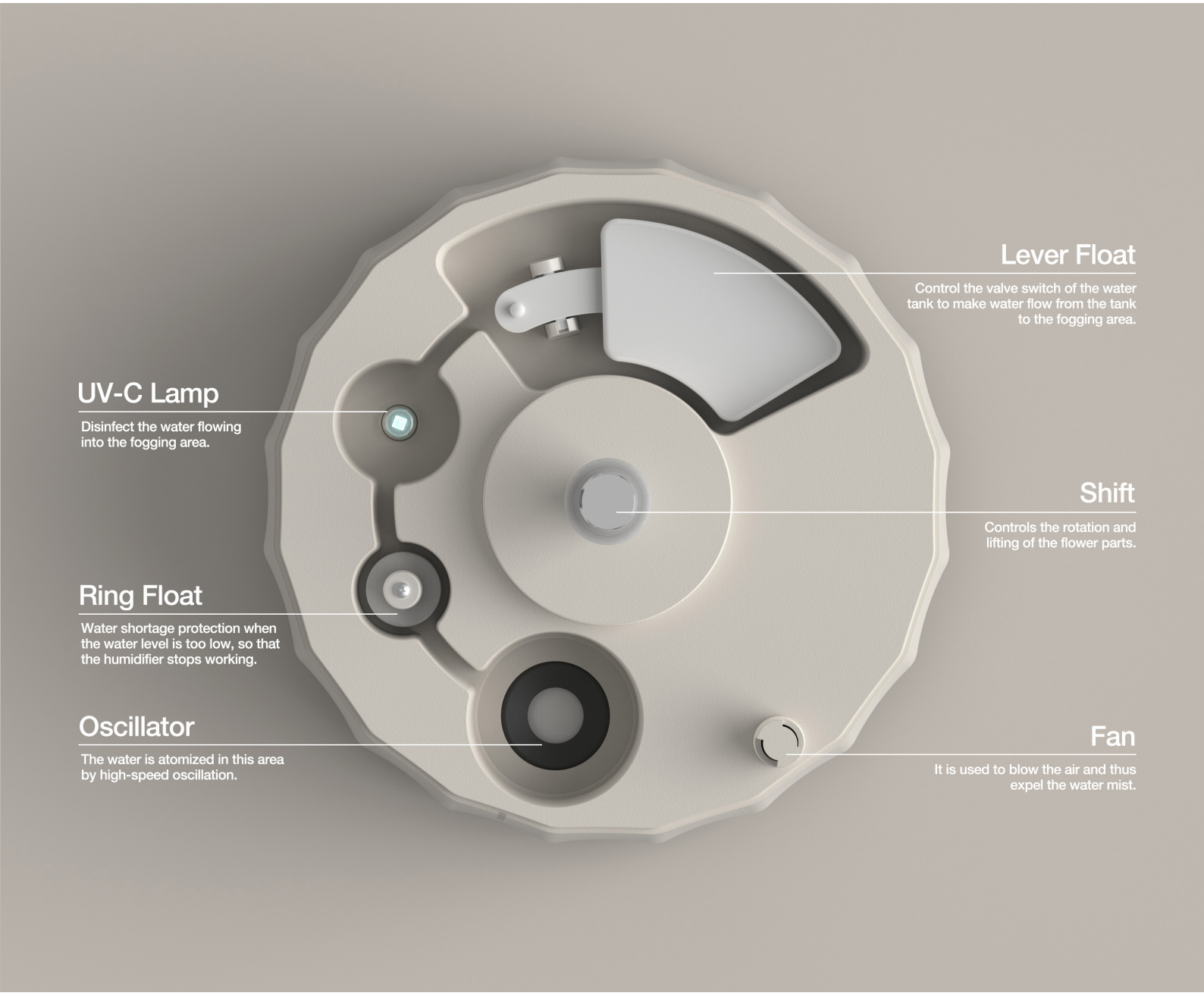
Image 93.
The general structure of the humidifier



5.6.2 Functional Blocks

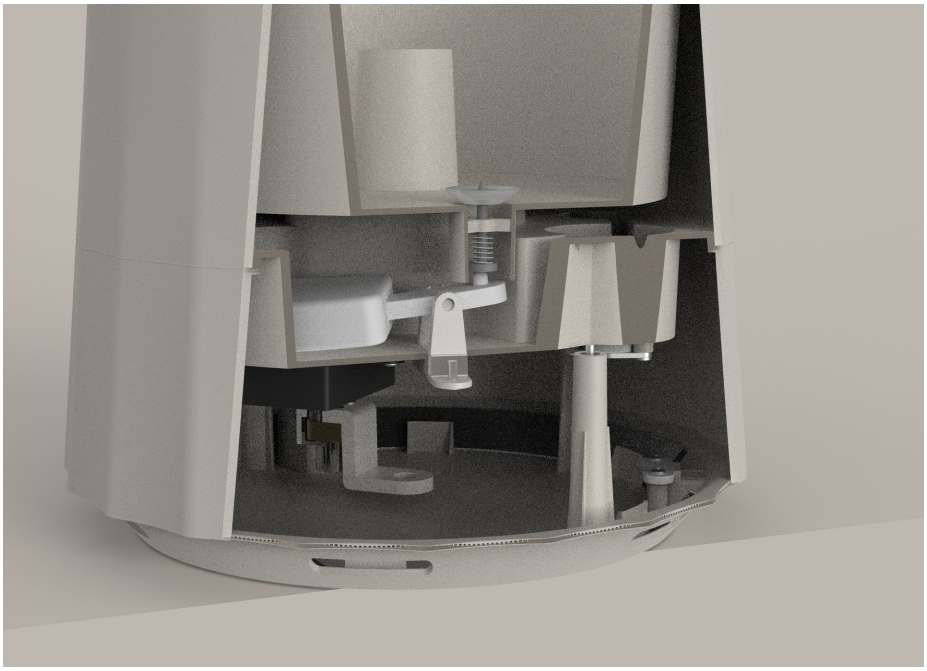
The humidifier body contains flower part, water tank, atomization function area and component area. Water flows into the atomization function area from inside the water tank and passes through each working module inside the function area one by one, so that water is gradually processed until mist is produced.

Image 94.
Functional blocks of humidifier



① Lever Float

One section of the lever float is a piece of float made of PP, and the other end is a part that can top open the valve of the water tank. When the atomization work area is short of water, the float end sinks, and due to the lever principle, the other end of the mechanism tops open the valve, so that the water in the water tank flows into the work area. As the water level in the working area gradually rises, the float floats up, thus driving the other end of the mechanism down, and the valve closes under the action of the spring, preventing the water in the tank from continuing to flow into the working area, thus making the whole process a closed loop, so that the water level in the working area is always kept at a fixed level.



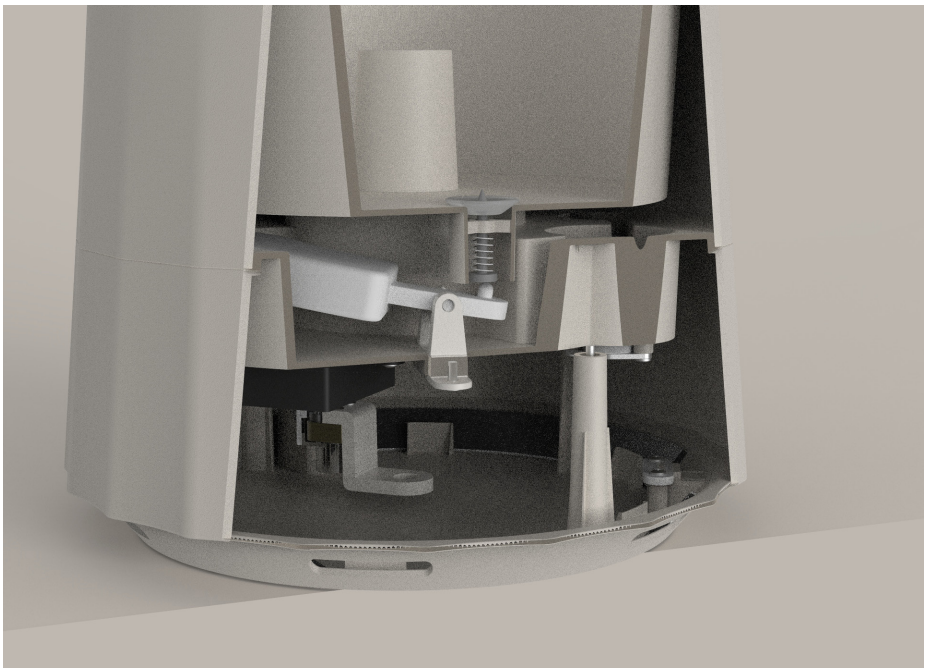


Image 95-96.
The working principle of lever float

② UV-C Lamp

The water flows into the UV-C lamp area at the very beginning, and in this area the water will be disinfected, thus ensuring the cleanliness of the water being atomized.

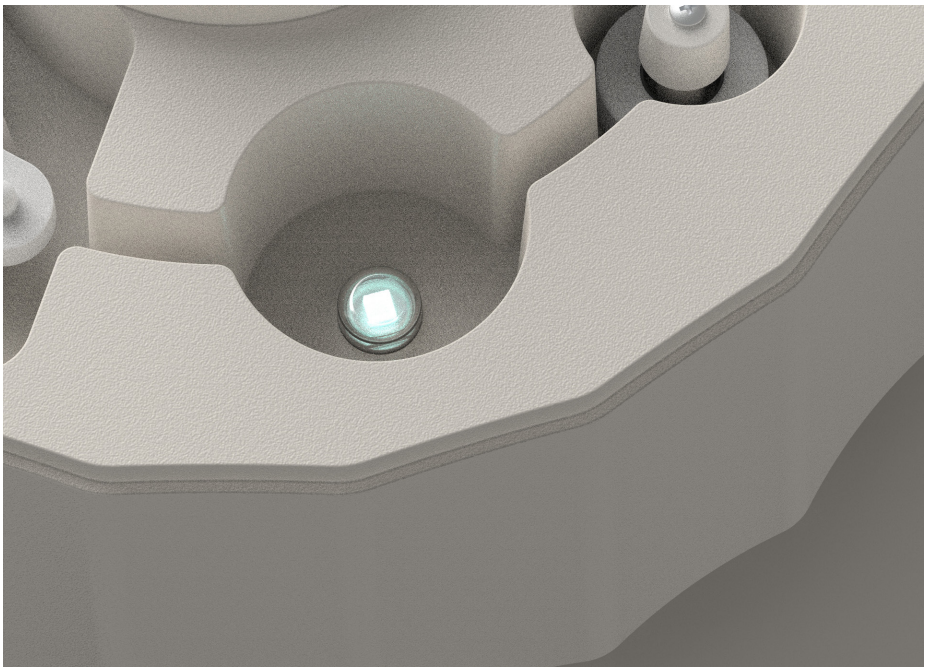


Image 97.
Details of the UV-C lamp

③ Ring Float Switch

When the humidifier works normally, the water in the working area is sufficient, the ring float floats upward, so that the magnet is far from the magnetic switch inside the humidifier, thus ensuring the normal work of the humidifier. When there is a shortage of water inside the water tank, the atomization work area will also be short of water, making the ring-shaped float sink, and the magnet inside the float is close to the magnetic switch inside the humidifier, thus cutting off the power supply and making the humidifier stop working. Therefore, this part acts as a kind of water shortage protection device to avoid the dangerous state that the oscillator works like when there is a water shortage.

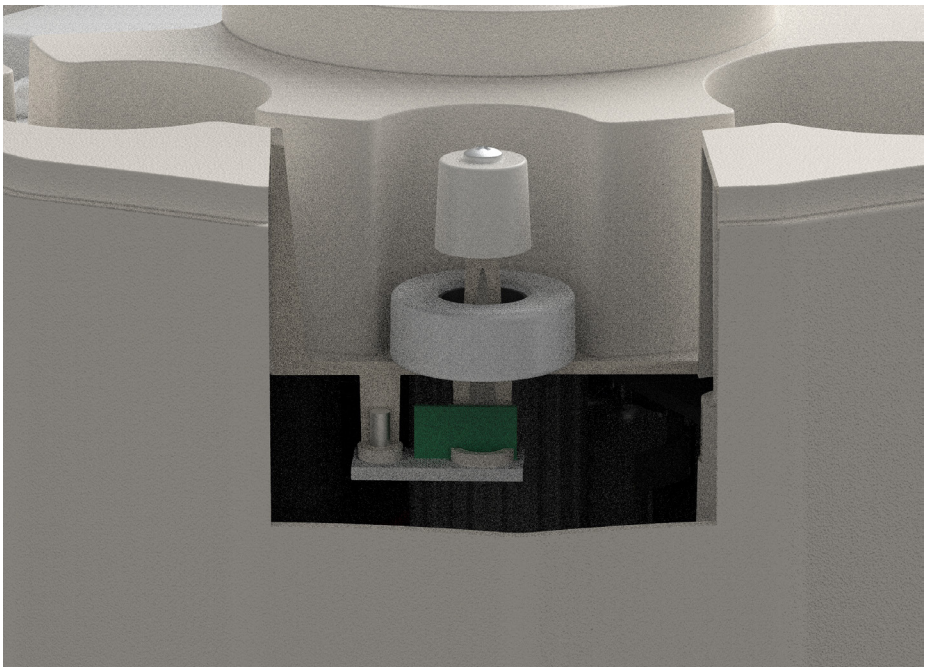


Image 98.
Details of the Ring Float Switch

④ Oscillator

The water in the tank will finally flow into the oscillator area, where the water will become water mist under the high frequency oscillation of the oscillator. It is then expelled into the air.

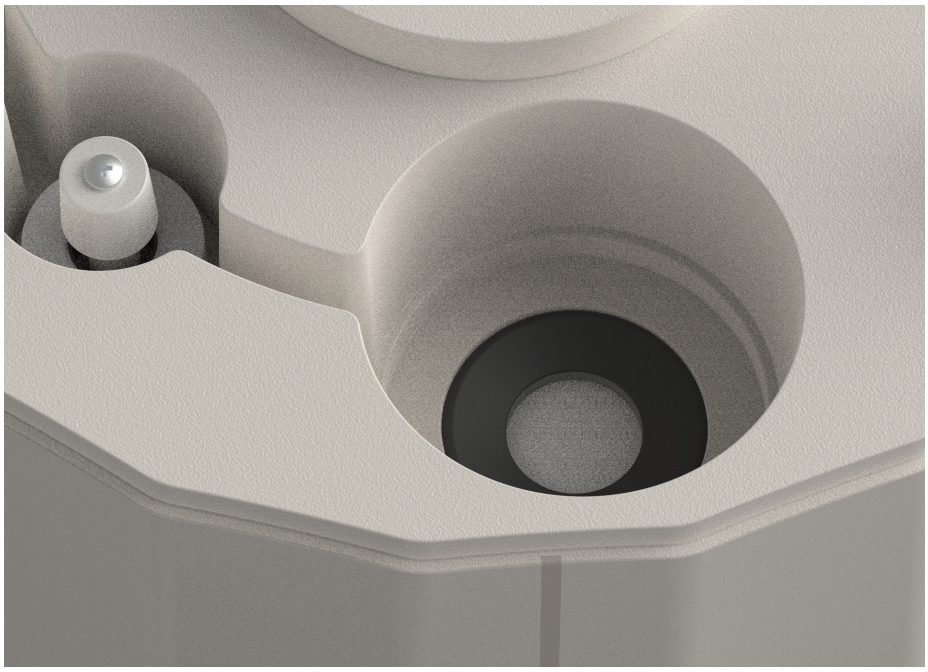


Image 99.
Details of the oscillator

⑤ Magnet Switch

A magnet is installed below the water tank, when the water tank is normally placed on the humidifier base, the magnet below the water tank is close to the magnet switch inside the base, so that the circuit is closed and the humidifier can be used normally. Once the user picks up the water tank, the magnet will be separated from the magnet switch, the circuit will be broken, and the humidifier stops all work. The purpose of this design is to ensure that when the tank is separated from the humidifier is the oscillator to stop working, so that the water mist will not wet the desktop, while the UV lamp also stopped working to protect the safety of the user.

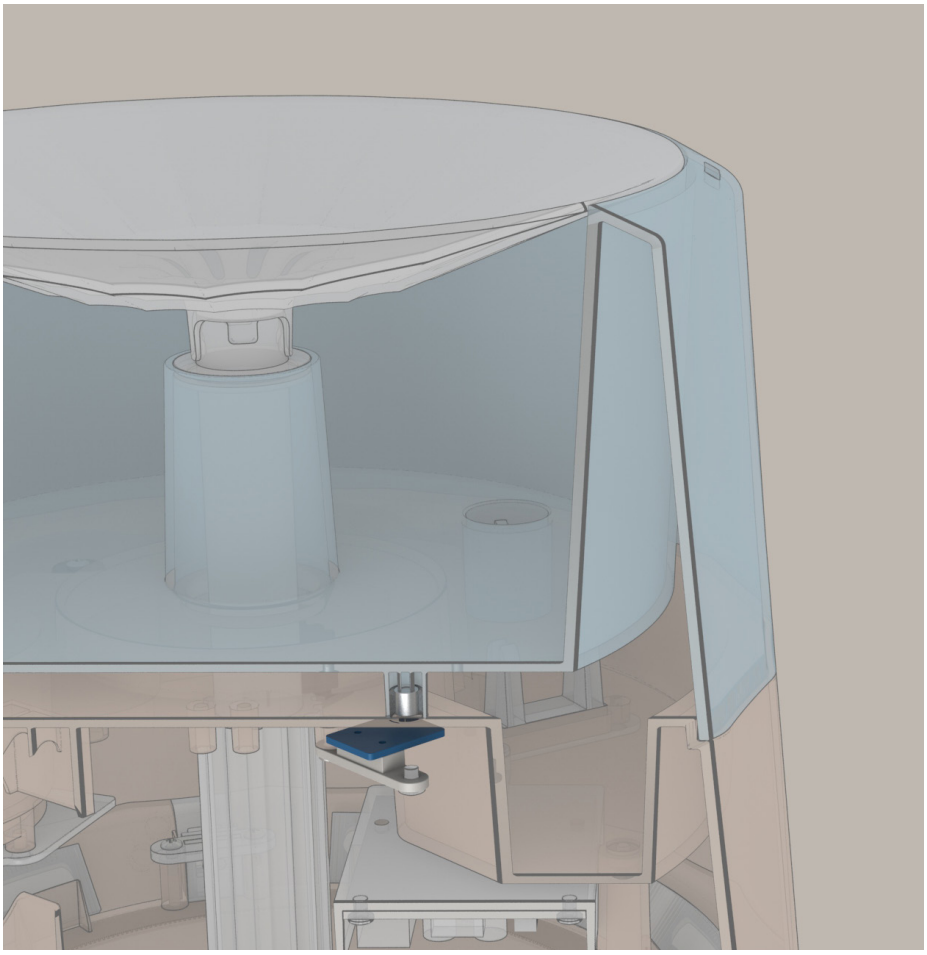


Image 100.
Details of the magnet switch

⑥ Fan

The fan is installed inside the base of the humidifier and exhausts air through the exhaust air hole at the top. The direction of the exhaust air hole is parallel to the circular direction at the top of the working area, which allows the water mist to be fully pushed into all the internal spaces of the humidifier and eventually pushed into the room air through the duct.

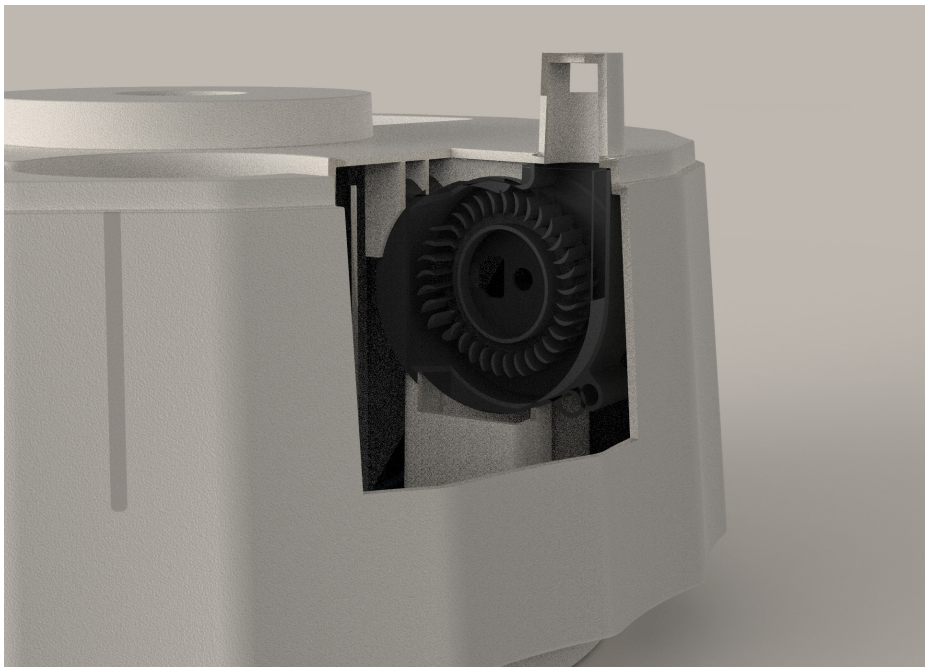


Image 101.
Details of the fan

Image 102.
Details of the air purification module

⑦ Air Purification Module

As the fan forms the air pressure difference between the inside and outside of the humidifier, resulting in the air being sucked in from the bottom of the humidifier, and the bottom of the humidifier is set with an air purification module and filtering cotton, making the air sucked into the humidifier purified, and thus improving the cleanliness of the mist produced by the humidifier.

5.7 Atomization Process

The flow of water inside the humidifier and the flow of water mist is roughly as shown in the figure. After the water is added to the tank from the top of the humidifier, it will flow along the valve to the working area, and then all the way to the atomization area, in which the water will be atomized by the oscillator and become water mist. After that, it will be driven by the fan through the outlet pipe and finally pushed into the room air.

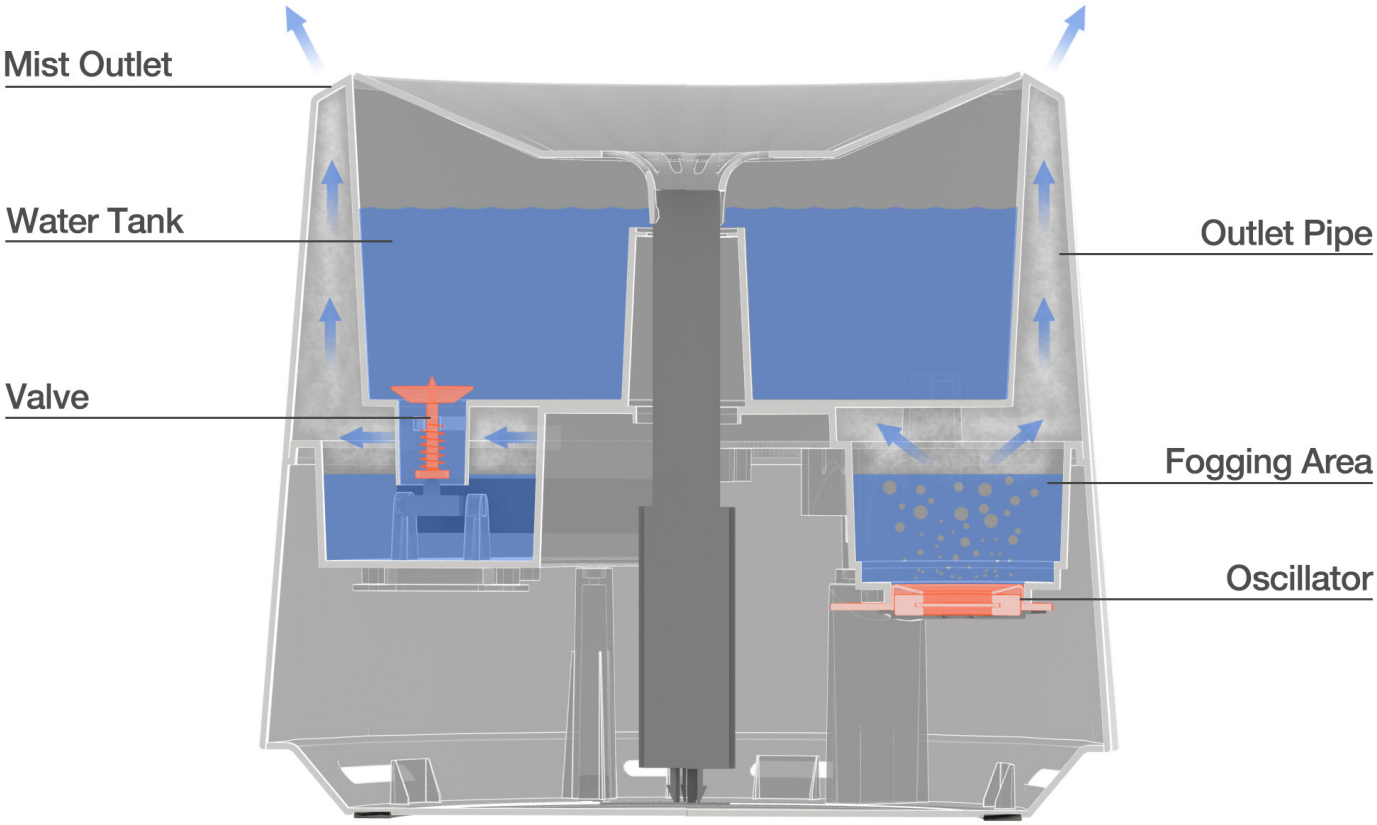


Image 103.
The working principle of humidifier atomization

5.8 Exploded View

All custom parts are designed according to production requirements. The parts to be purchased are also modeled strictly according to the engineering drawings. The overall structure of the product takes into account the ease of assembly and disassembly, so all parts are assembled and installed in a vertical orientation.As a final result, we prepared all the necessary product documentation, including production drawings, assembly drawings, and specification sheets of purchased components.

Image 104.
Exploded view of humidifier

5.9 Functional Core

5.9.1 Symbiosis of Flower

The flower component, as the core innovative component of the humidifier, integrates different aspects of the function, both aesthetically and functionally, and many design purposes are formed symbiotically in the flower component. Its main functions are expressed in the following aspects:

Firstly it serves as an imagery of an organic living being, the organic form mimics the form of a flowering plant, creating an emotional resonance as well as empathy and care for the humidifier, changing the traditional motivation of the user to use the humidifier.

Second, as an expression of dynamic design, it rises and falls to reflect the current air humidity level, thus giving users clear cues.

Third, its special form makes the part function as a funnel, allowing users to add water directly from the top of the humidifier to the water tank, while the process of adding water is similar to the process of watering flower, which can also be combined with the imagery of flower.

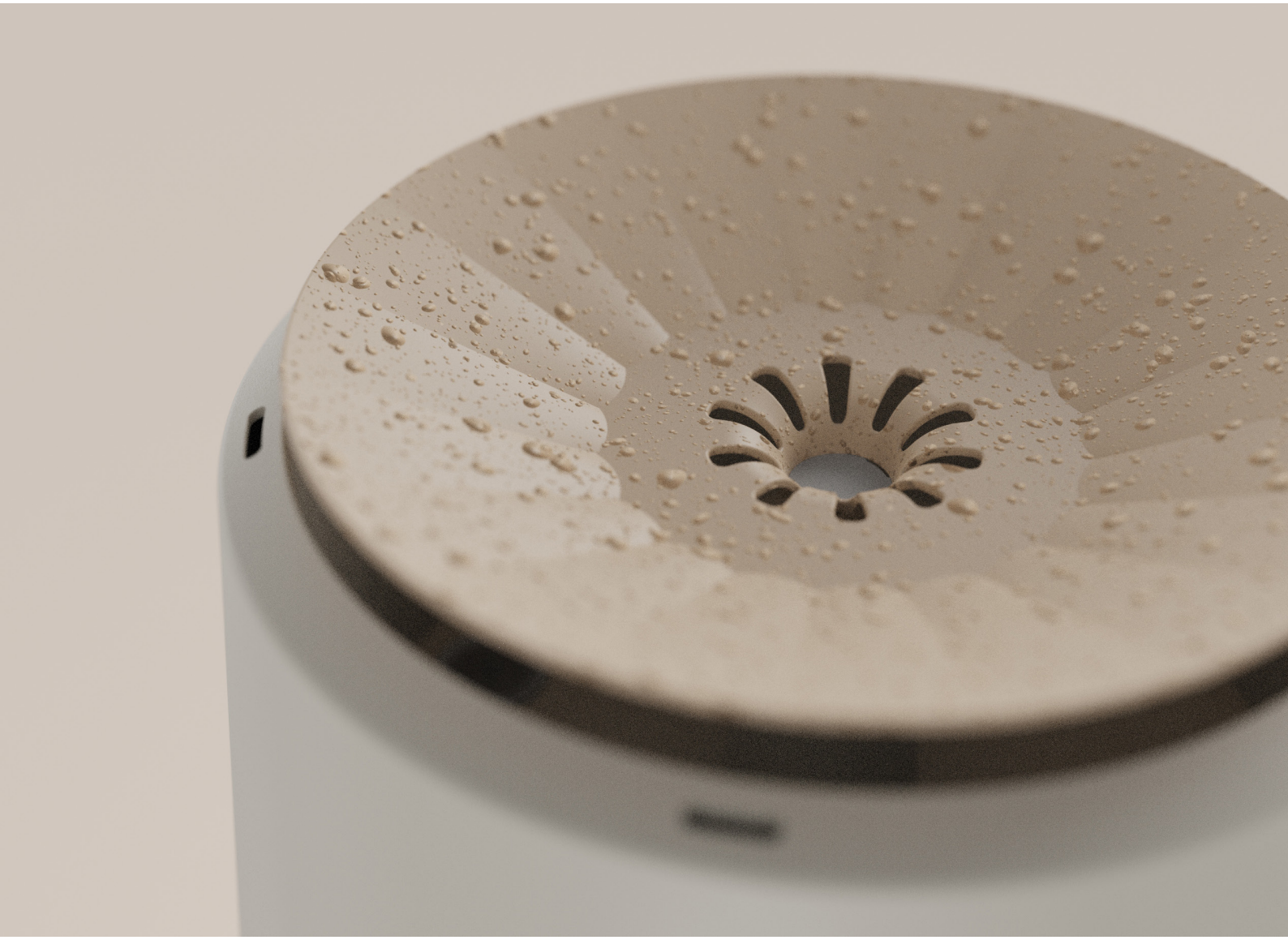


Image 105.
Detail view of the flower part

5.9.2 Core Mechanism

The core mechanism of the humidifier is the adjustment mechanism that controls the power and the mechanism that controls the lift of the flower.

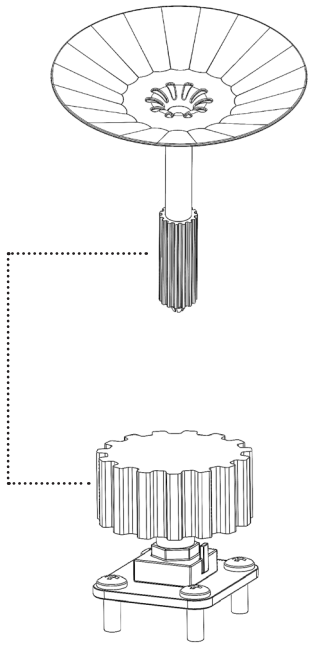
First of all, there are gears on the shift and connected to the flower parts, and the shift is connected to the knob switch with gears installed.

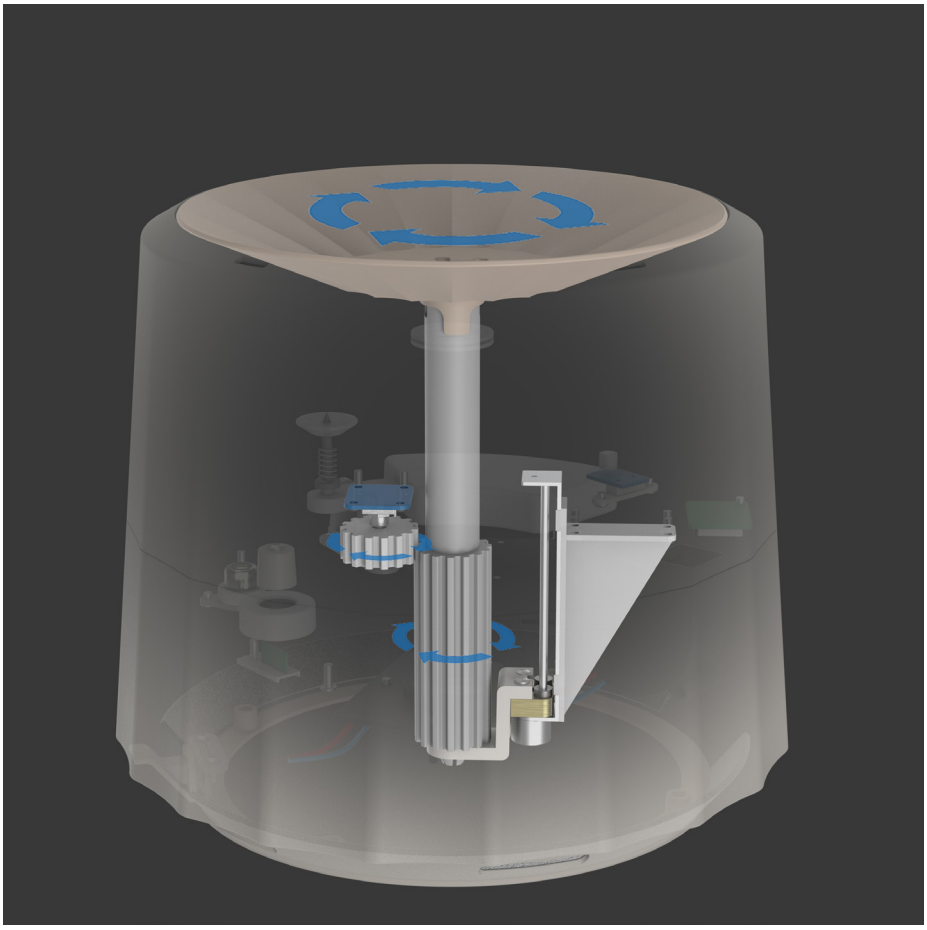
On the other hand, the bottom of the shift is connected to the linear actuator through the snap fit, and the linear actuator is controlled by the humidity sensor to change the height of the flower parts according to the humidity level of the room air.

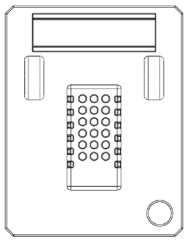
Because the rotational and up-down movements of the flower parts are independent, the two mechanisms are integrated without interfering with each other.

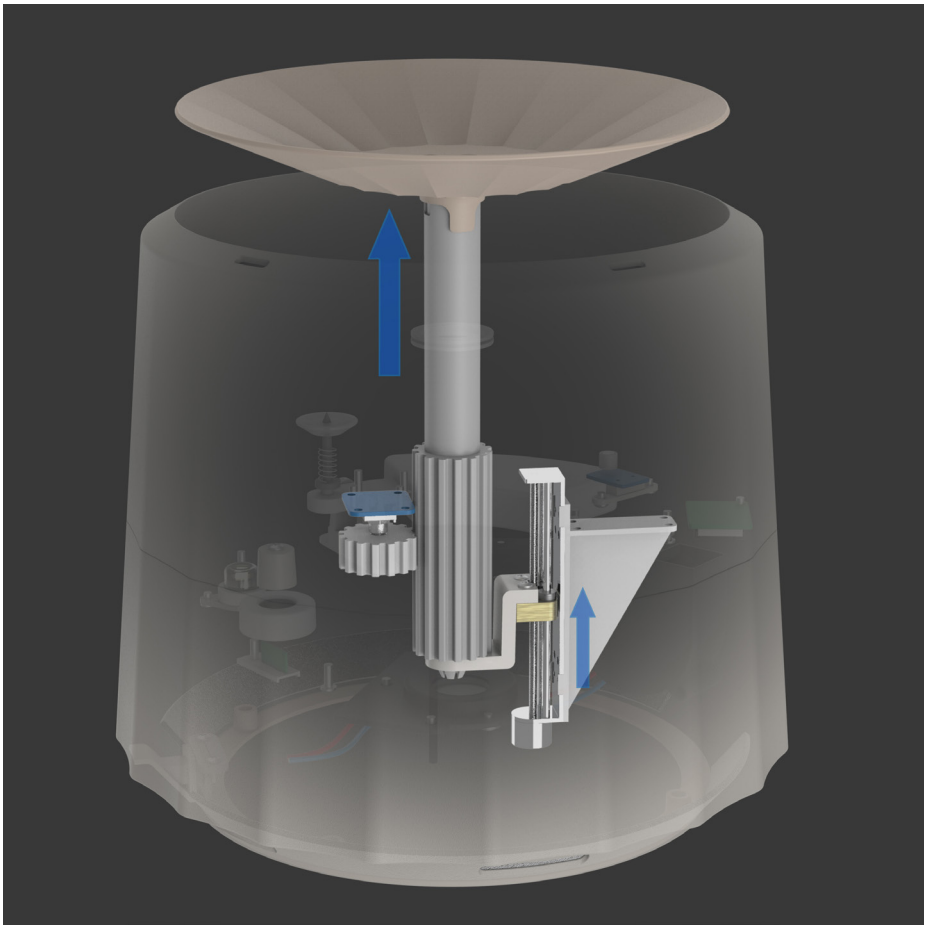
Image 106.
Mechanism for controlling the rotation of flower part

Image 107.
Mechanism for controlling the rise of flower part









5.10 Color Scheme

I conducted a detailed CMF analysis, including functional and aesthetic properties and extracted the feelings of versatility, durability, and cosiness we wanted to achieve with the materials used.In the following three color schemes, both high and low brightness color schemes for the main body are included, so that the product can meet the needs of different usage environments. But no matter which theme color scheme, the color scheme of the flower parts is always distinguished from the main body of the humidifier, in order to establish a clear division of the functional area and prompt the user the special function of the flower parts.

Image 108.
Three color schemes for humidifier

5.11 Usage Scenarios

Humidifier use environment is mainly for the indoor environment of the home.

Image 109.
Humidifier indoor use scene effect

6. Technical Report

6.1 Product Parameters

6.1.1 Calculation of Tank Size And Atomizer Power

First of all, the optimal relative humidity of air for humans is 45%-55%. As shown in the figure, bacteria, viruses, mites, etc., which are harmful to humans, have a small incidence in this range, so it can be concluded that This range is more suitable for humans.

Since the product needs to adjust the air humidity level of a room, it is assumed that the design goal is to increase the air humidity from 20% to 55% in 1.5 hours for a room with an area of 20 square meters. According to the average sleep time of the user, the battery life of the product needs to reach 8 hours.

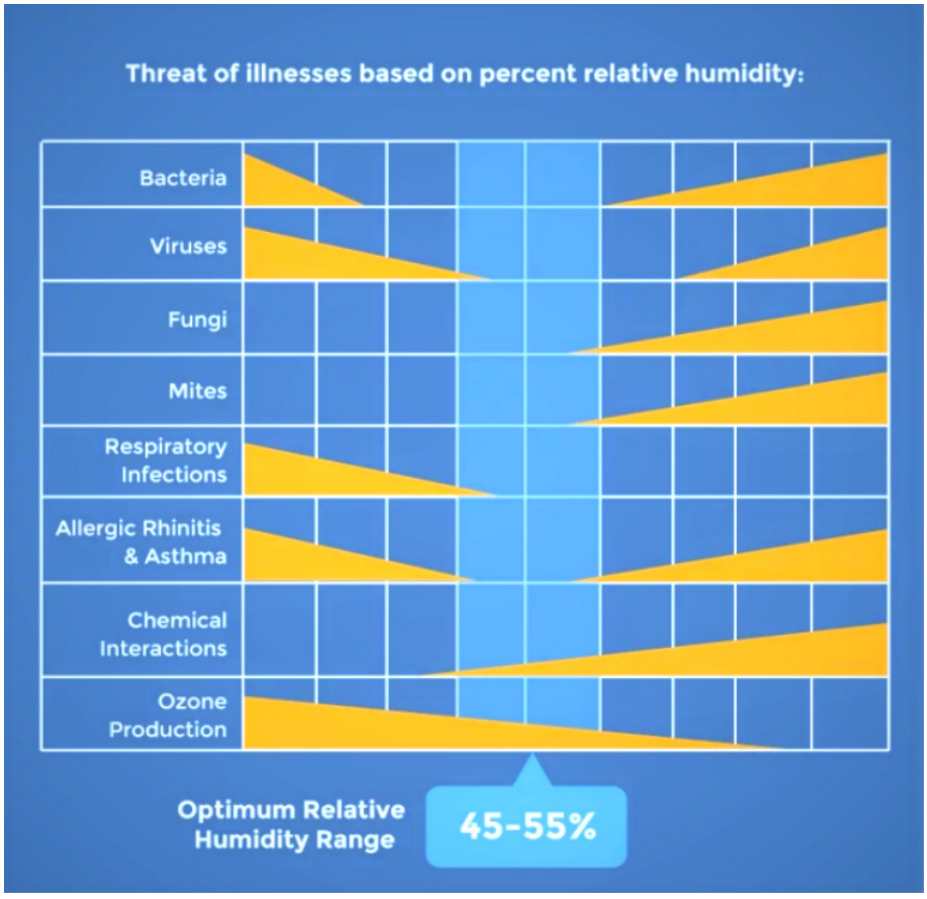


Table 2.
Threat of illnesses based on percent relative humidity
https://www.robertbpayne.com/perfect-indoor-humidity-for-all-seasons/

According to the moist air enthalpy diagram,
the moisture content of 20% and 55% air humidity is 3.07g/kg and 8.51g/kg,
so it is necessary to add 8.51-3.07=5.44g/kg of air to the air.
Assuming that the indoor height is 3m,
the indoor air volume is 20*3=60m^2,
and the air density is about 1.2kg/m³,
it can be obtained that the indoor air content is 60*1.2=72 kg.
Therefore, it is necessary to add 72*5.44=392g of water to the air.
According to the target completed in 1.5 hours,
the mist output of the product is 392/1.5=260ml/h.
According to the 8-hour endurance goal,
the volume of the water tank needs to be 260*8=2080ml=2.08L.
According to the humidification efficiency formula η=Q/W, and the humidification efficiency range of each gradient of the ultrasonic humidification scheme is "7~13", and the average value is 10.
Therefore, the power of the atomizing tablet is 260/10=26W.

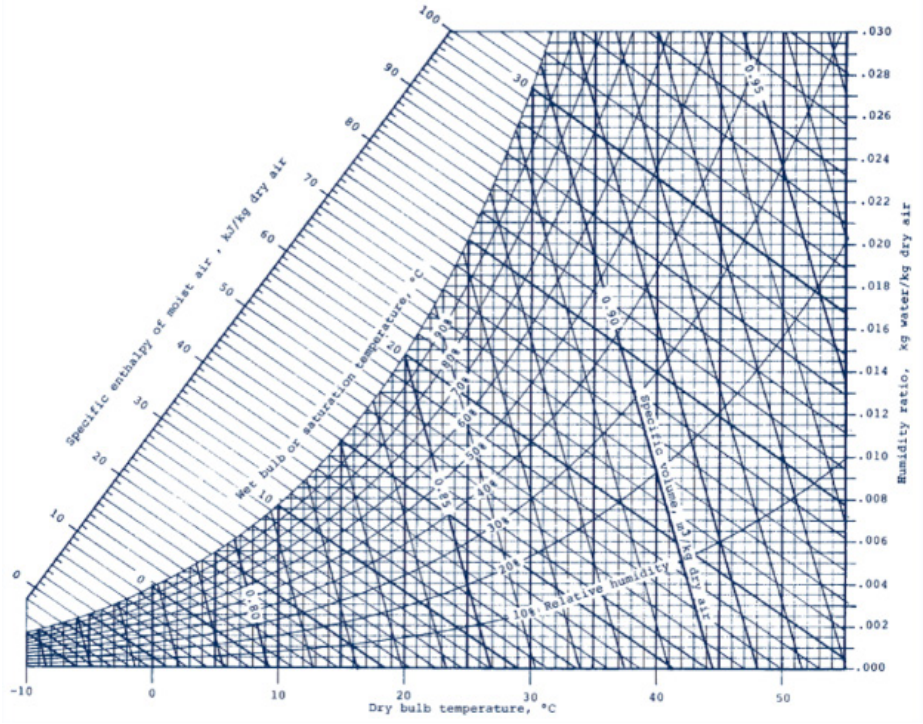


Image 110.
Moist air enthalpy diagram
https://www.buildenvi.com/gongju/psychrometrics

6.1.2 Basic Dimensions

According to the previous analysis and calculations, the product's water tank volume needs to be at least 2.08L. Based on this, combined with the limitations of the component size and the functional requirements of the product, I came up with the following basic dimensions of the product.

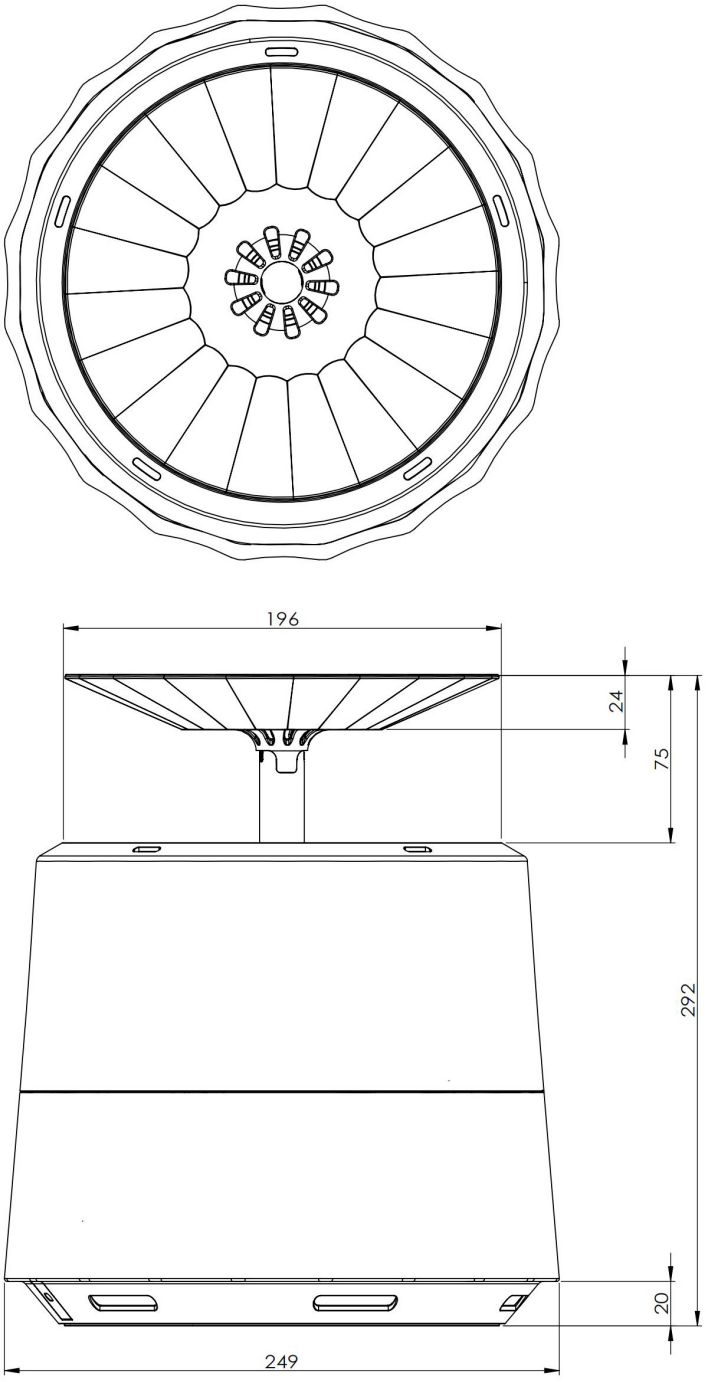
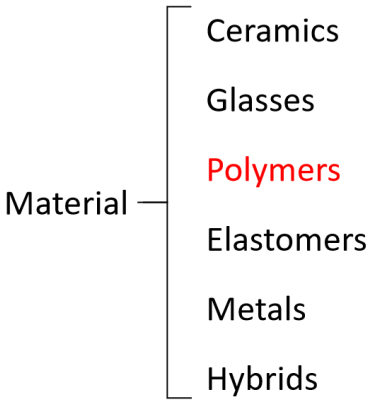


Image 111.
General view of the humidifier

6.2 Material Selection

6.2.1 Material Selection of Main Product Body

Qualitative Analysis
After product research and analysis, the main material of the humidifier should first have a certain hardness and toughness, good insulation, corrosion resistance and shape plasticity, and preferably a low-density lightweight material.
According to the above requirements, the author chose polymer as the main material of the product.



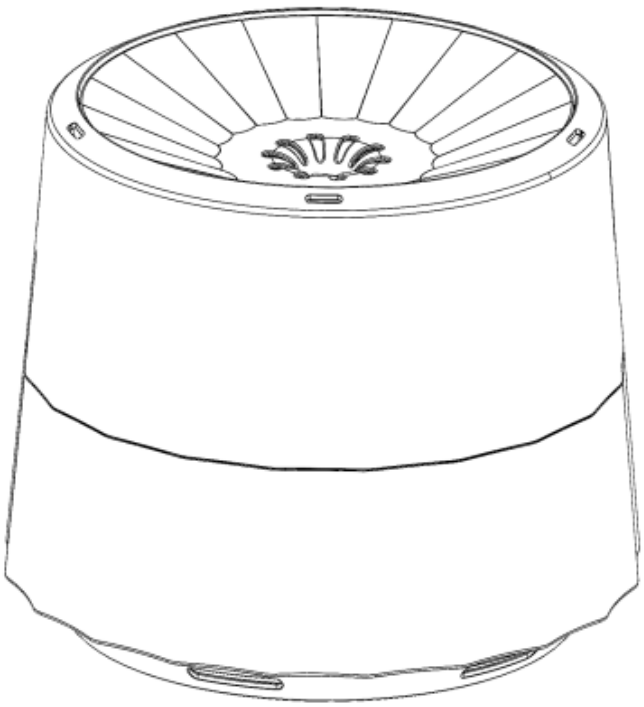


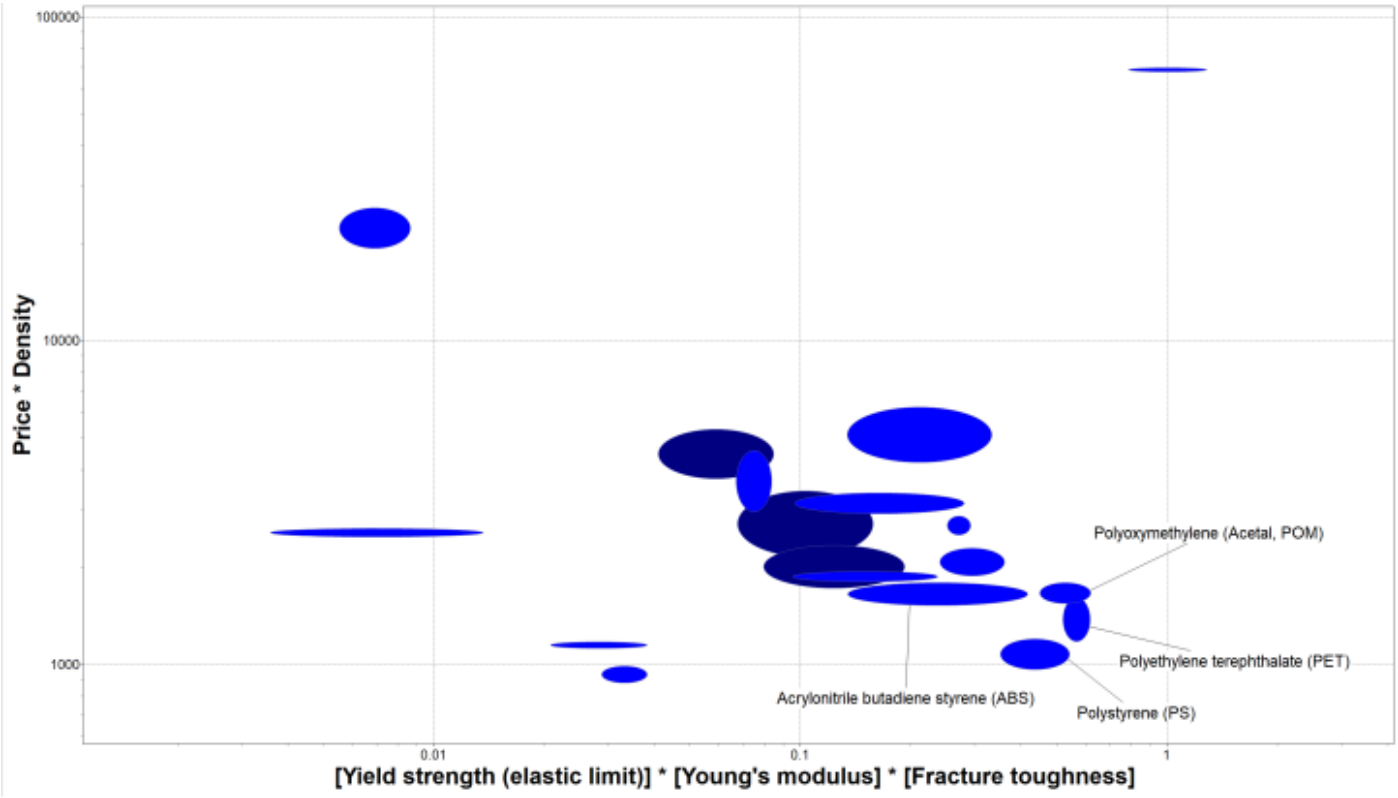
Image 112.
Main product body

Qualitative Analysis

Through the screening of yield strength, Young's modulus, fatigue strength, density and cost, ABS, PET, POM, PS are the materials that meet the requirements. Then through the screening of coloring performance, non-toxicity and toughness, the author finally decided to use ABS as the main material of the product.

Table 3-4.
Comparison of the basic parameters of the four alternative plastics

	Young's modulus	Yield strength	Fracture toughness	Density	Price
ABS	2.07-2.76GPa	34.5-49.6MPa	1.46-4.29MPa.m^0.5	1.03e3-1.06e3 kg/m^3	1.46-1.71EUR/kg
PET	2.8-3GPa	50-55MPa	4.75-5.25MPa.m^0.5	1.29e3-1.39e3 kg/m^3	0.885-1.2EUR/kg
POM	2.6-3.2GPa	57.2-71.7MPa	3.8-4.2MPa.m^0.5	1.39e3-1.41e3 kg/m^3	1.11-1.28EUR/kg
PS	3-3.5GPa	28.7-41.4MPa	3.71-4.49MPa.m^0.5	1.04e3-1.05e3 kg/m^3	0.92-1.15EUR/kg



6.2.2 Material Selection of Mechanical Components

The internal mechanical parts of the product are mainly the shift of the core mechanism, and the user manually rotates the flower parts to drive the internal shift and the gear of the knob. Therefore, the material of this part needs to be corrosion resistant and have sufficient fatigue strength, Young's modulus and yield strength, and on top of that, the material needs to have low density. Using the above criteria I selected and ranked the plastics and finally chose POM as the material for the core mechanism.

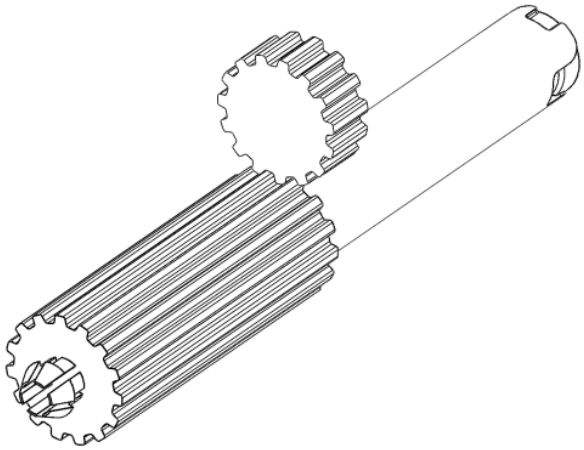
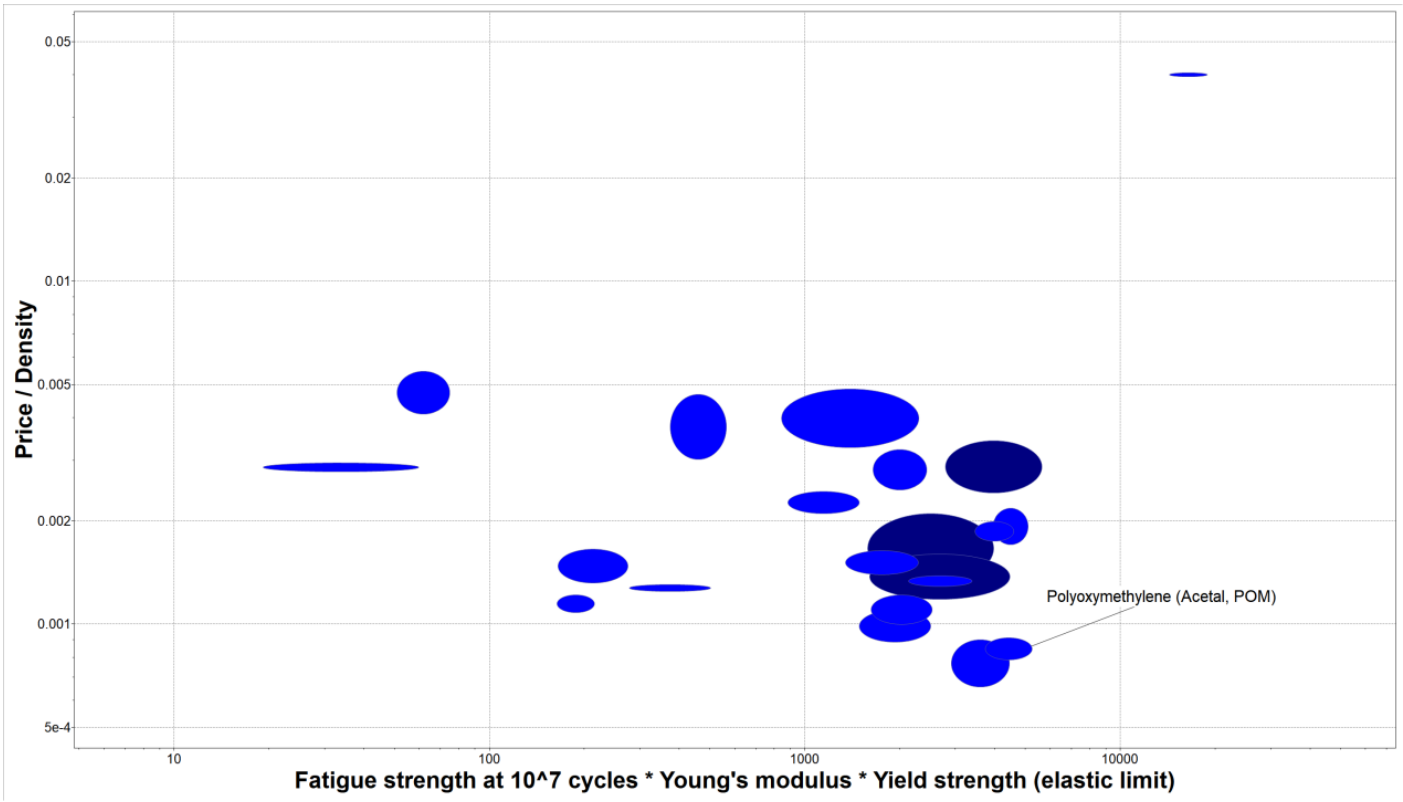


Image 113.
Sketch of core organization

Table 5.
Material selection for the core mechanism



6.2.3 Material Selection of Lever Float

The lever float is used to control the opening and closing of the tank valve. When the atomization work area is short of water, the float can open the valve due to its own gravity and the lever principle, thus allowing the water in the tank to flow into the atomization work area. As the water level in the area rises, the float moves up, thus closing the valve and stopping the inflow of water.
Due to the above functional requirements, the material of the float is required to have enough gravity for opening the valve in the first place. On the other hand, the material of the float needs to have a density less than that of water so that it can float on the water surface. The material should also be water resistant and easy to process and mass produce.
After comparing plastics that are easy to mass-produce and water-resistant, PP was finally selected as the material for the float among those with a density less than 1000 kg/m=3, and then in order of cost.

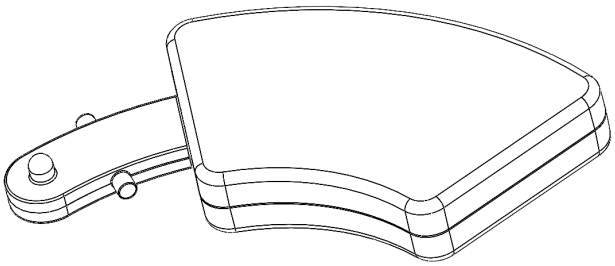
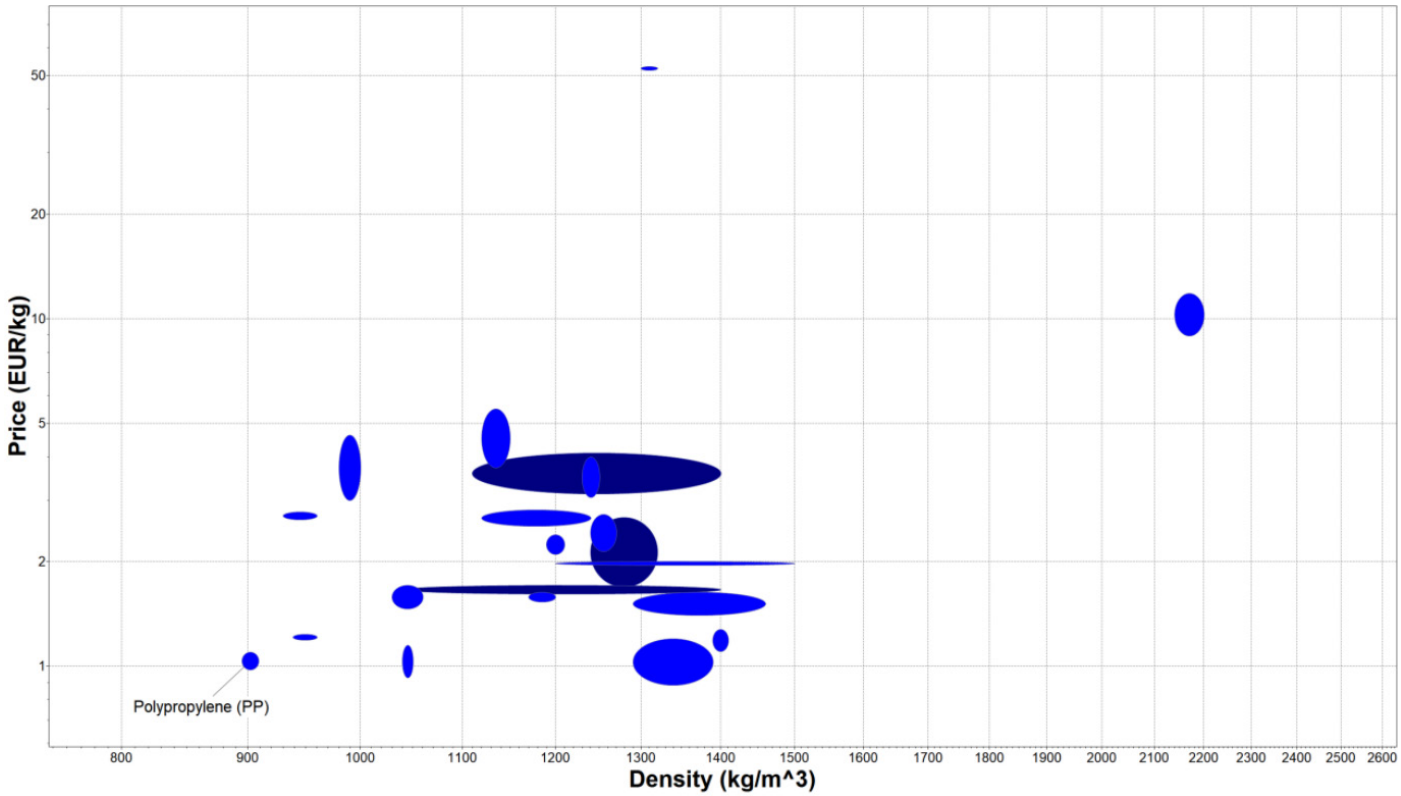


Image 114.
Sketch of lever float

Table 6.
Material selection of lever float



6.2.4 Material Selection of Rubber

**The non-slip pad at the bottom of the humidifier and the water barrier ring between the top of the tank and the shaft need to be made of thermosetting rubber.
By screening and ranking the cost as well as the fatigue strength, I finally chose Polyurethane as the material for these two parts.**

Image 115-116.
The non-slip pad at the bottom of the humidifier and the water barrier ring between the top of the tank and the shaft

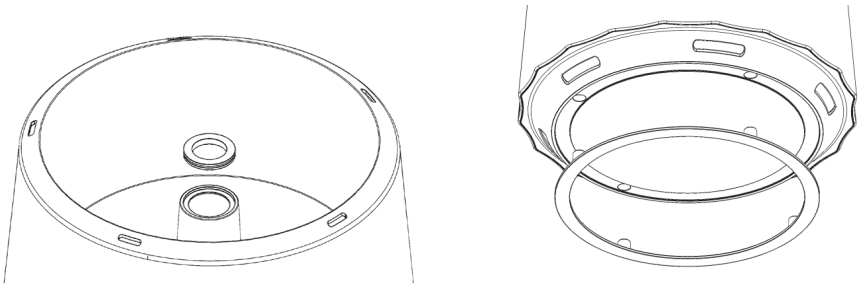
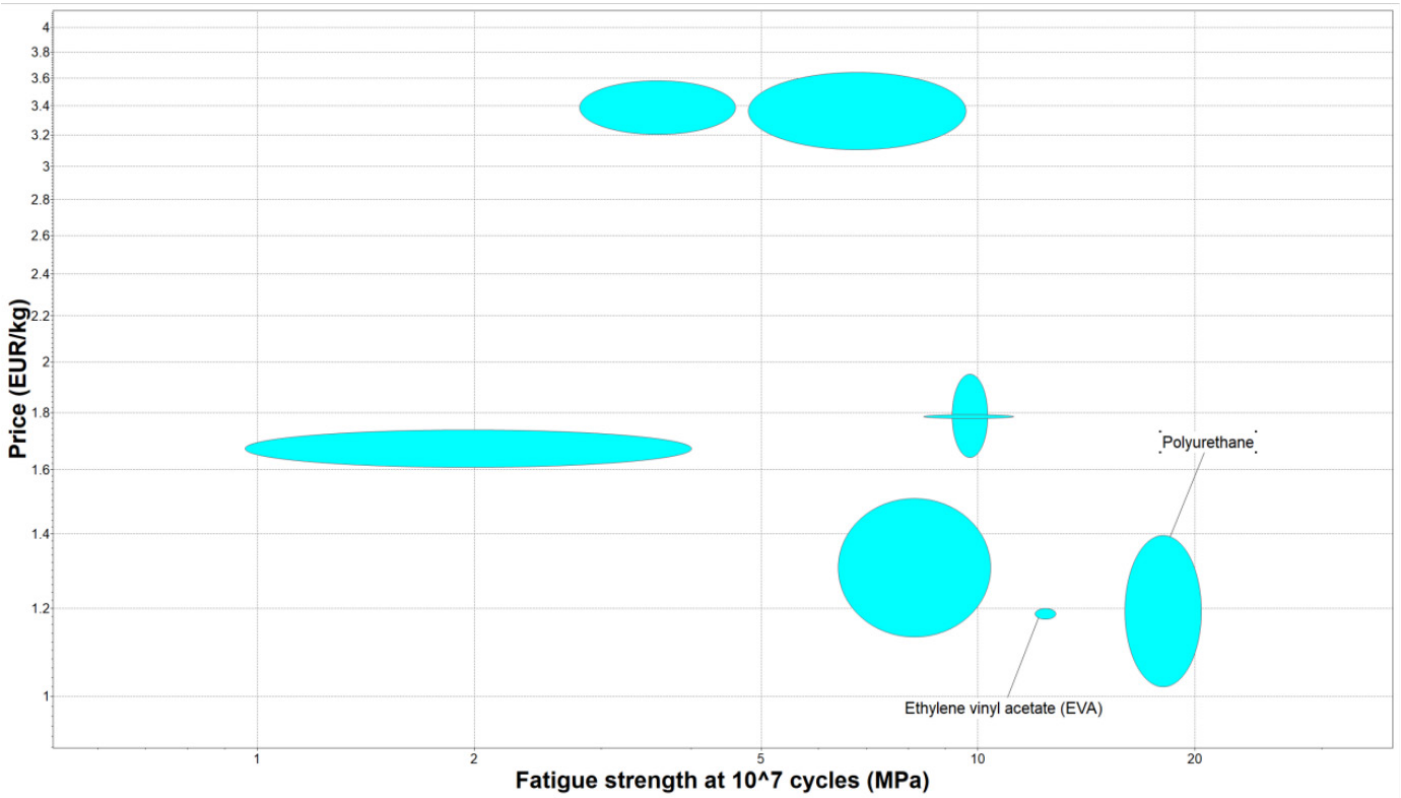


Table 7.
Material selection of rubber

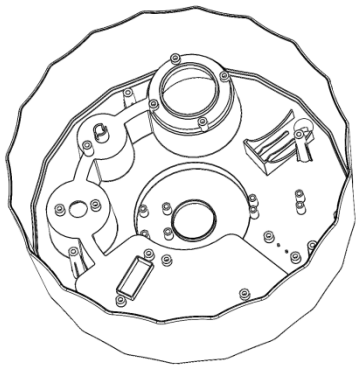


6.3 Process Selection

6.3.1 Process of Main Product Body

The main parts of the humidifier include the flower parts, the water tank, and the base shell, all of which are made of ABS. Considering their shape and the need for mass production, I decided to use the injection molding process to make them.

Image 117-118.
Sketch of the lower part of the humidifier and the lower lid



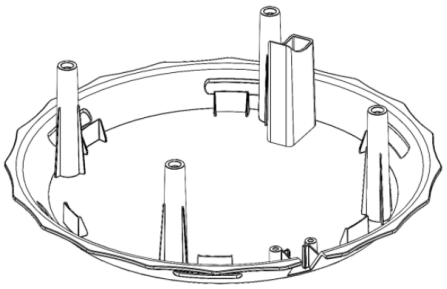
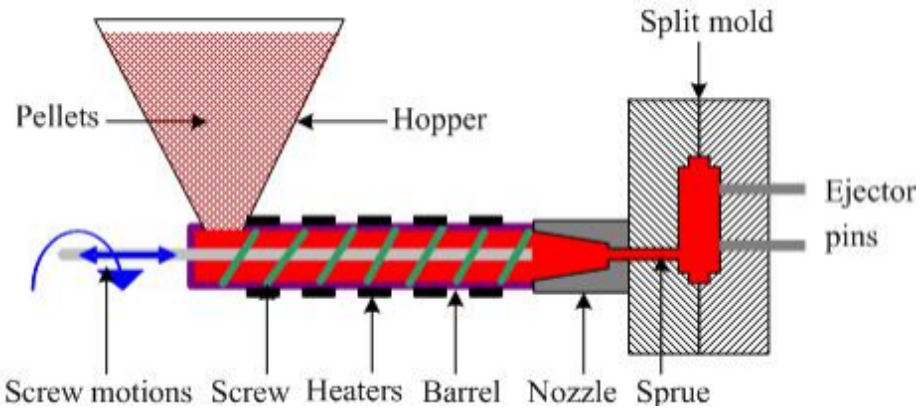
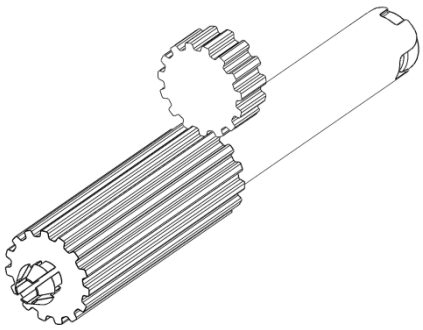


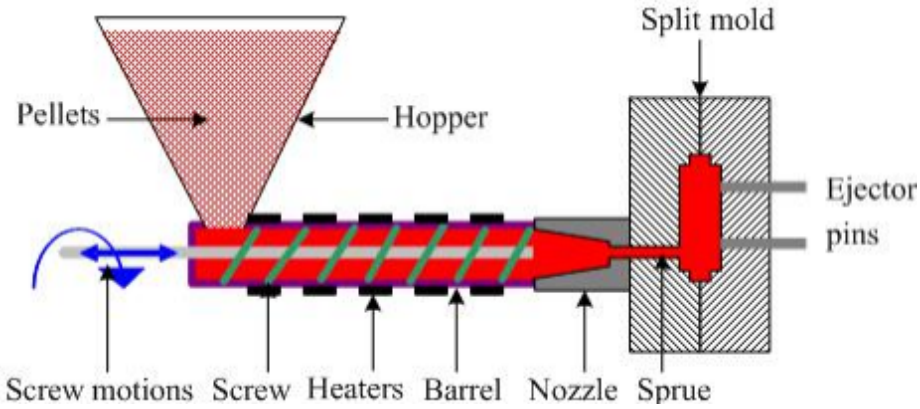
Image 119.
Injection molding process



6.3.2 Process of Core Mechanism

The core mechanism contains shift and gear. Due to its special shape and details, it is not suitable to be processed by integral injection molding, so I decided to use both injection molding and gear hobbing for processing the basic shape of shift as well as gear.





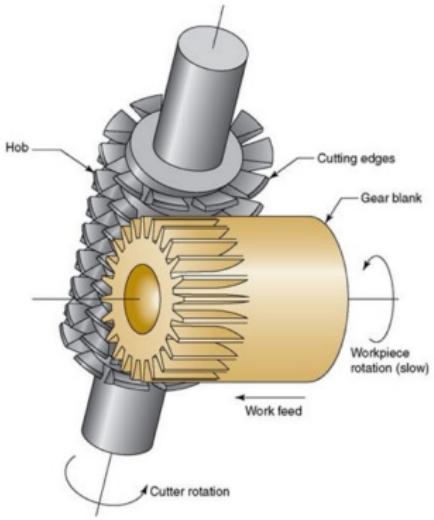


Image 120.
Sketch of core organization

Image 121.
Injection molding process

Image 122.
Gear hobbing process

6.4 Connection Method

6.4.1 Screw Connection

The installation of the internal components of the humidifier and the overall assembly of the humidifier base are screwed together.

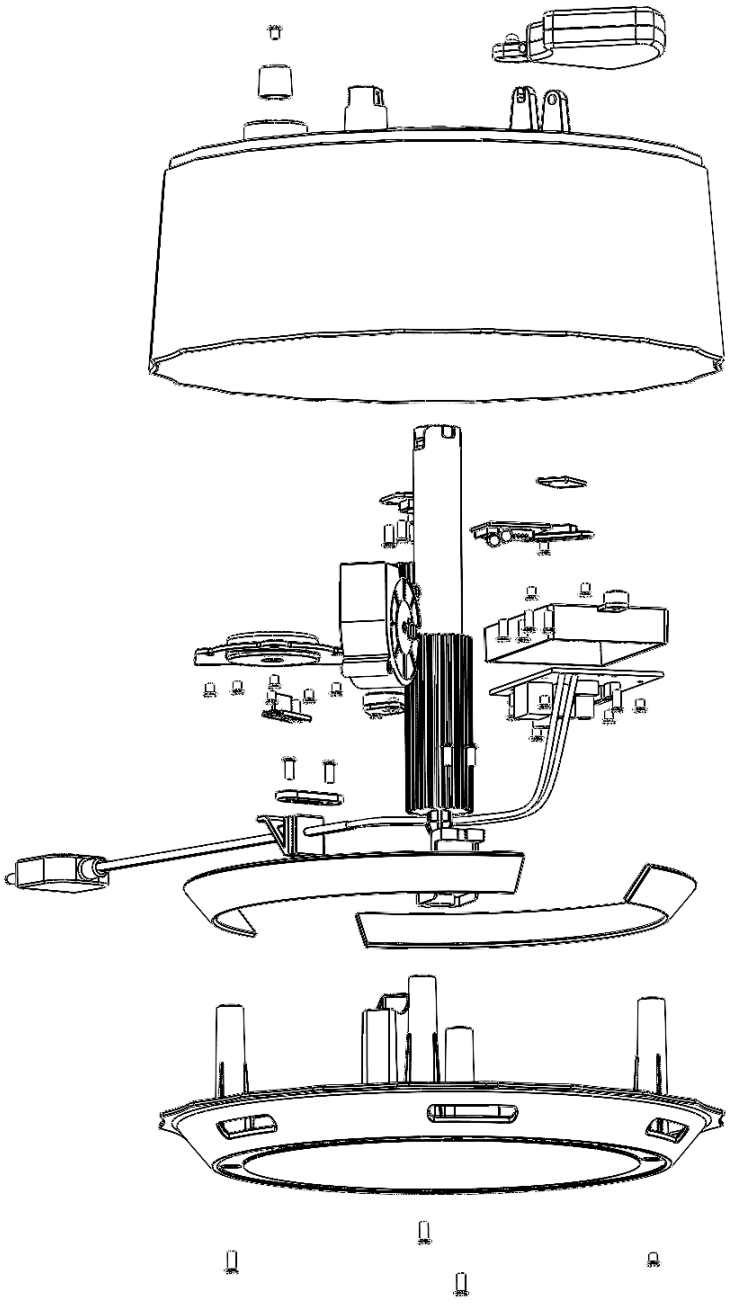


Image 123.
Connection method of product body

6.4.2 Snap Fit Connection

The flower parts, shift and connection parts, and the linear actuator and base are assembled using Snap Fit connections, where the flower parts are detachable for the purpose of easy disassembly and cleaning of the parts by the user.

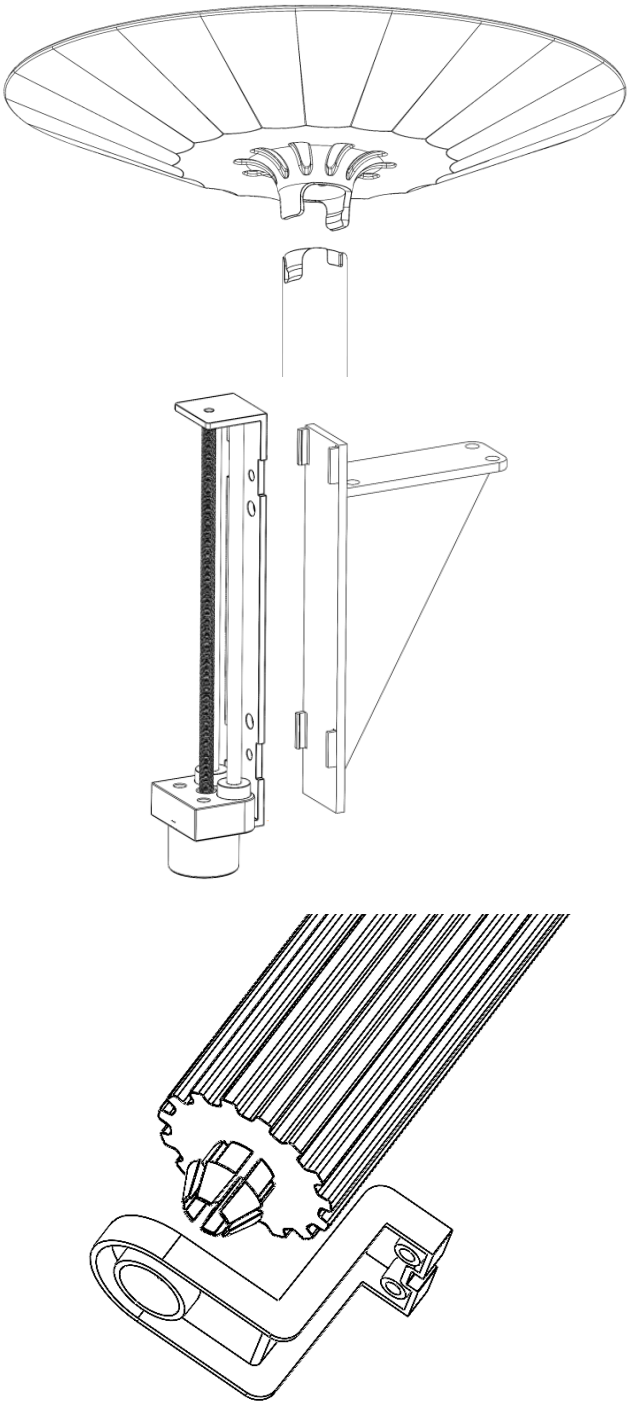
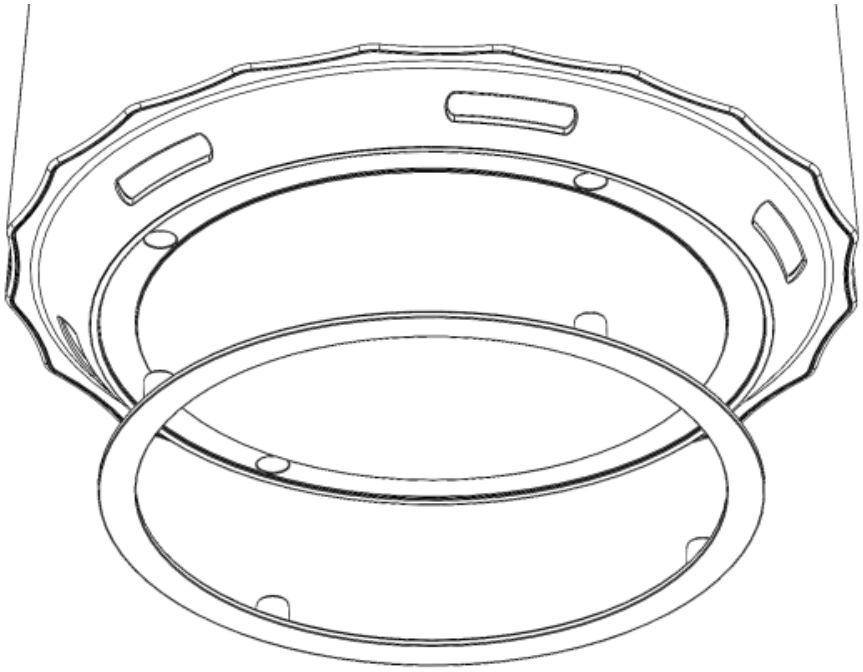


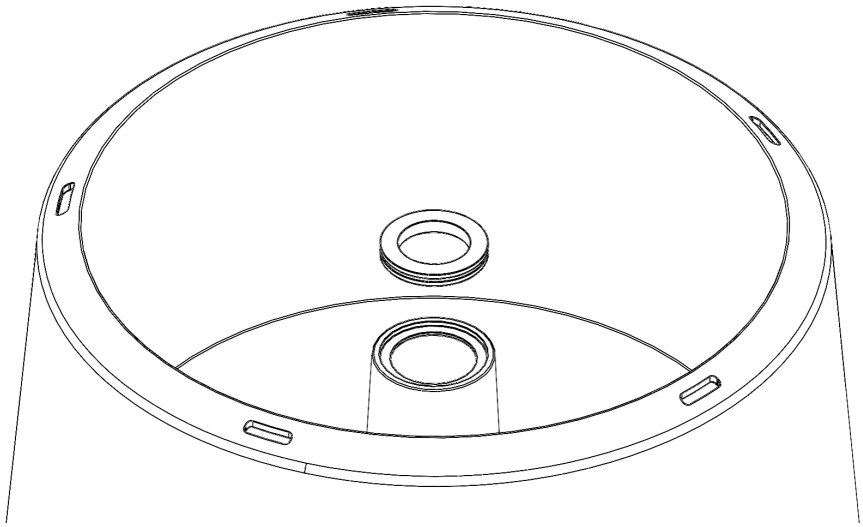
Image 124-126.
Connection of flower part and linear actuators and shifts

6.4.3 Glue Connection

The rubber bottom of the humidifier and the lower cover and the top of the tank and the water barrier between the use of glue connection. Installation of rubber bottom is conducive to simple and rapid completion of the installation of the product, rubber bottom is conducive to increasing the friction between the product and the desktop, thereby enhancing the stability of the product, on the other hand, can also cover the bottom of the screw holes, so that the humidifier as a whole more concise.

Image 127-128.
The non-slip pad at the bottom of the humidifier and the water barrier ring between the top of the tank and the shaft





6.5 Component Selection

6.5.1 Linear Actuator Analysis

The most central component of this product is the mechanism that raises and raises the top part. To achieve this movement, I considered a number of motor and hinge options, however, the ideal solution was to use a linear actuator. The linear actuator made the desired motion possible due to its large thrust and controllability of speed. Finally, after considering size, power, and price, I chose the Micro 15mm Stepper Motor as the core mechanism. The following are the basic parameters of this linear actuator.
Drive voltage: DC4-9V/100-500mA, motor diameter: 15mm, screw length: 90mm, slider stroke: 80m, thread pitch: 0.5mm, screw diameter: 3mm, motor diameter: 15mm, phase resistance: 15.5 Ohm.The unit price is 12 euros.

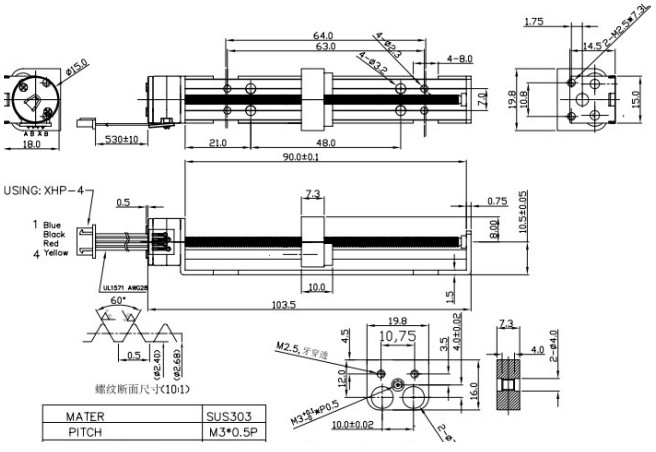


Image 129-130.
Micro 15mm Stepper Motor
https://www.taobao.com/list/item/wap/556525099781.htm

6.5.2 Oscillator

Oscillator as the core functional components of the ultrasonic humidifier, is also very important. After the previous article for the oscillator power demand calculation, the power of the oscillator needs to reach at least 26W, as a premise, and then after the size, price and other restrictions, I chose a 35W humidifier universal oscillator, the unit price of 4 euros.

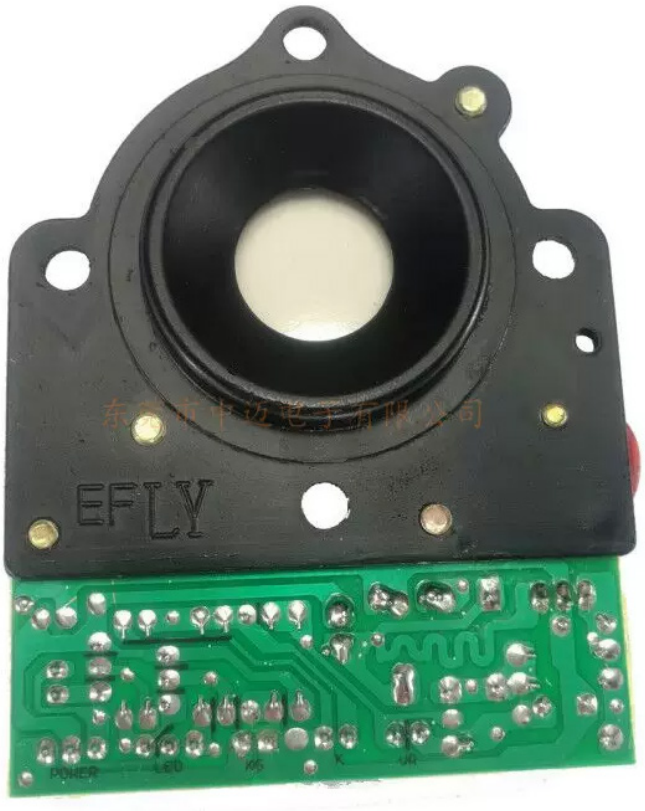
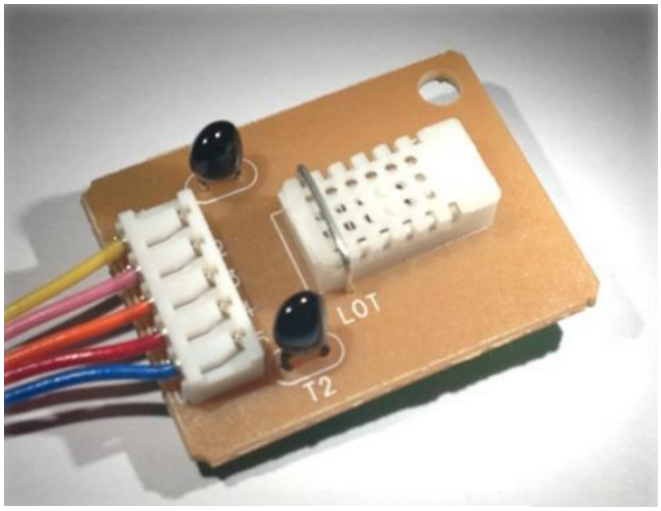


Image 131.
35W Oscillator
https://www.taobao.com/list/item/5846916392.htm

6.5.3 Humidity Sensor

The humidity sensor in this design is used to control the motion of the linear actuator. The following is a brief description of the humidity sensor I have chosen.
Resistance type humidity sensor: SYH-2R offers cost effective and convenient humidity measurement.
While maintaining the attractive features such as no-calibration requirement and high Interchangeability of resistive type humidity sensor : SYH-2R widens the scope of applications to home appliances, HVAC, and automotive.Coated with patented polymer, SYH-2R can be used in demanding environments (-20°C~85°C) with frequent condensing and chemical vapors.
SYH-2R can be directly connected to μ-com with ADC or RFC converting resistance changes to either voltage or frequency. It can also be modularized to voltage output with oscillator.



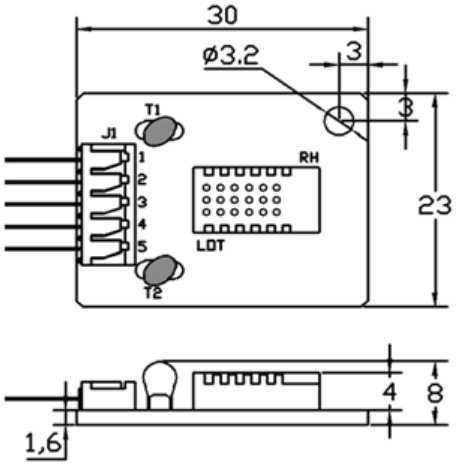


Image 132-133.
SYH-2R
https://www.tme.eu/en/details/syh-2rc/humidity-sensors/samyoung/syh-2r/

Electrical Specification

Parameter	Value
Rated Voltage	AC $5V_{peak}$ ($1V_{RMS}$ recommended)
Rated Power	0.26mW (at $5V_{peak}$)

Environmental

Parameter	Symbol	Value	Unit
Operating Temperature Range	T_s	-20~85	℃
Operating Humidity Range	RH	20~90	%RH
Storage Temperature Range	T_{stg}	-30~85	℃
Storage Humidity Range		Less than 95%RH	%RH

Sensor Performance

Relative Humidity (RH%)

Humidity Characteristics	Symbol	Min.	Typ.	Max.	Unit
Standard Characteristic (at 25℃, 60%RH,1Vrms, 1 kHz)			33		KΩ
Operating Frequency Range		0.1		10	kHz
Relative Humidity Accuracy (at 25℃, 60%RH)			±3		%RH
Humidity Hysteresis (at 25℃, 40⇔80%RH)			±2		%RH
Response Time (40⇔80%RH))		60			sec.
Temperature Coefficient	T_{cc}		0.5		%RH/℃

Table 8.
Electrical specification
https://www.tme.eu/en/details/syh-2rc/humidity-sensors/samyoung/syh-2r/
Table 9.
Environmental
https://www.tme.eu/en/details/syh-2rc/humidity-sensors/samyoung/syh-2r/
Table 10.
Sensor performance
https://www.tme.eu/en/details/syh-2rc/humidity-sensors/samyoung/syh-2r/

6.5.4 Fan

The fan voltage is generally 12V, 24V, 36V, etc. The shock board breaks up the water droplets into tiny particles and continuously blows them away through the fan, so that water mist is continuously formed. When the lack of water is detected, the fan is also turned off at the same time. According to the size of the internal space and the comprehensive consideration of the fan power, I chose a 24 V fan as the humidifier exhaust device.The noise level is 20 decibels. The unit price is 5 euros.

Image 134.
24 V fan
https://www.taobao.com/list/item/wap/571397108610.htm

6.5.5 UV-C Lamp

Inside the humidifier needs to be effective disinfection of water, so as to optimize water quality, while the treatment of water should be fast and simple, does not occupy too much space. Therefore, I chose to use UV lamps to sterilize the water. After comparing the power, cost and disinfection efficiency, I chose a UV lamp with an operating voltage of 5V and an input current of 100mA.The unit price is 6 euros.

Project	Symbol	Condition	Minimum	Average value	Max	Unit
Forward Voltage	Vf	100mA	12	--	24	V
Max Forward Current	Ifmax	--	--	--	120	mA
UVC Radiant Flux	Po	100mA	4	--	8	mW
UVC Forward Current	If	--	--	100	--	mA
UVC Peak Wavetength	λp	100mA	270	--	280	nm

Table 11.
Basic parameters of UV-C Lamp
https://aliexpress.ru/item/1005003149233215.html

Image 135.
Selected UV-C Lamp
https://aliexpress.ru/item/1005003149233215.html

6.5.6 Rotary Angle Sensor

The design adjusts the oscillator power by the user manually rotating the flower, which is connected to the internal Rotary Angle Sensor, and the rotation of this sensor adjusts the oscillation period switch and the power change. After comparing various products I chose the EC11 rotary encoder rated at 5V.The rotary angle sensor produces analog output between 0 and Vcc (5V DC with Seeeduino) on its D1 connector. The D2 connector is not used. The angular range is 300 degrees with a linear change in value. The resistance value is 10k ohms, perfect for Arduino use. This may also be known as a “potentiometer ”. Single price of 3 euros.

Image 136.
EC11 rotary encoder
https://wiki.seeedstudio.com/cn/Grove_IoT_Developer_Kit-Microsoft_Azure_Edition/

6.5.7 Ring Float

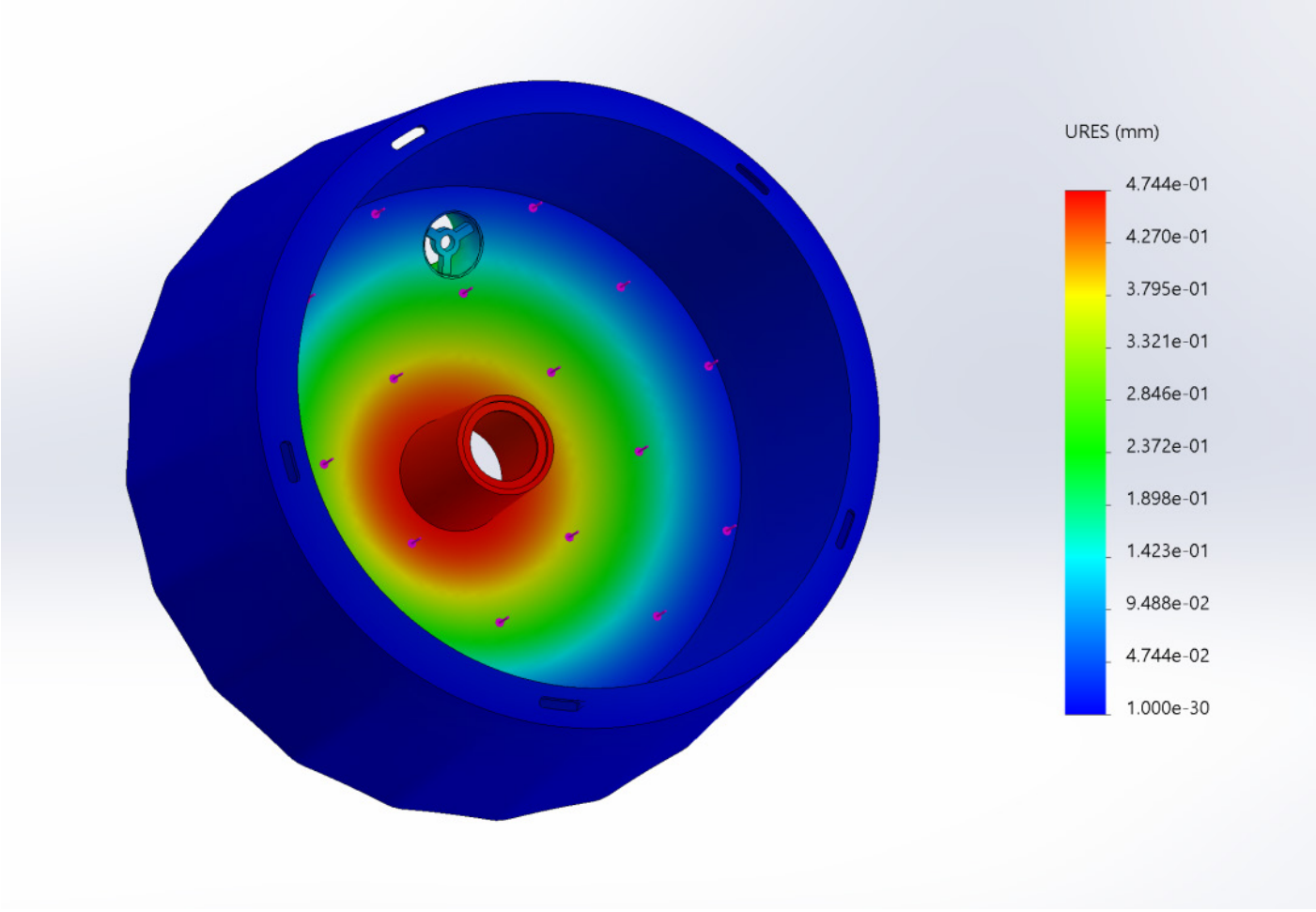
Water shortage protection is one of the basic functions of the humidifier. When the water inside the tank runs out, the float inside the humidifier sinks and the magnet inside the float controls the switch inside the humidifier so that the humidifier stops working. I finally chose the humidifier water level float which is common in the market and the unit price is 0.8 Euro.

Image 137.
Ring float
https://redmondsale.com/catalog/686/1952/

6.6 FEM Analysis

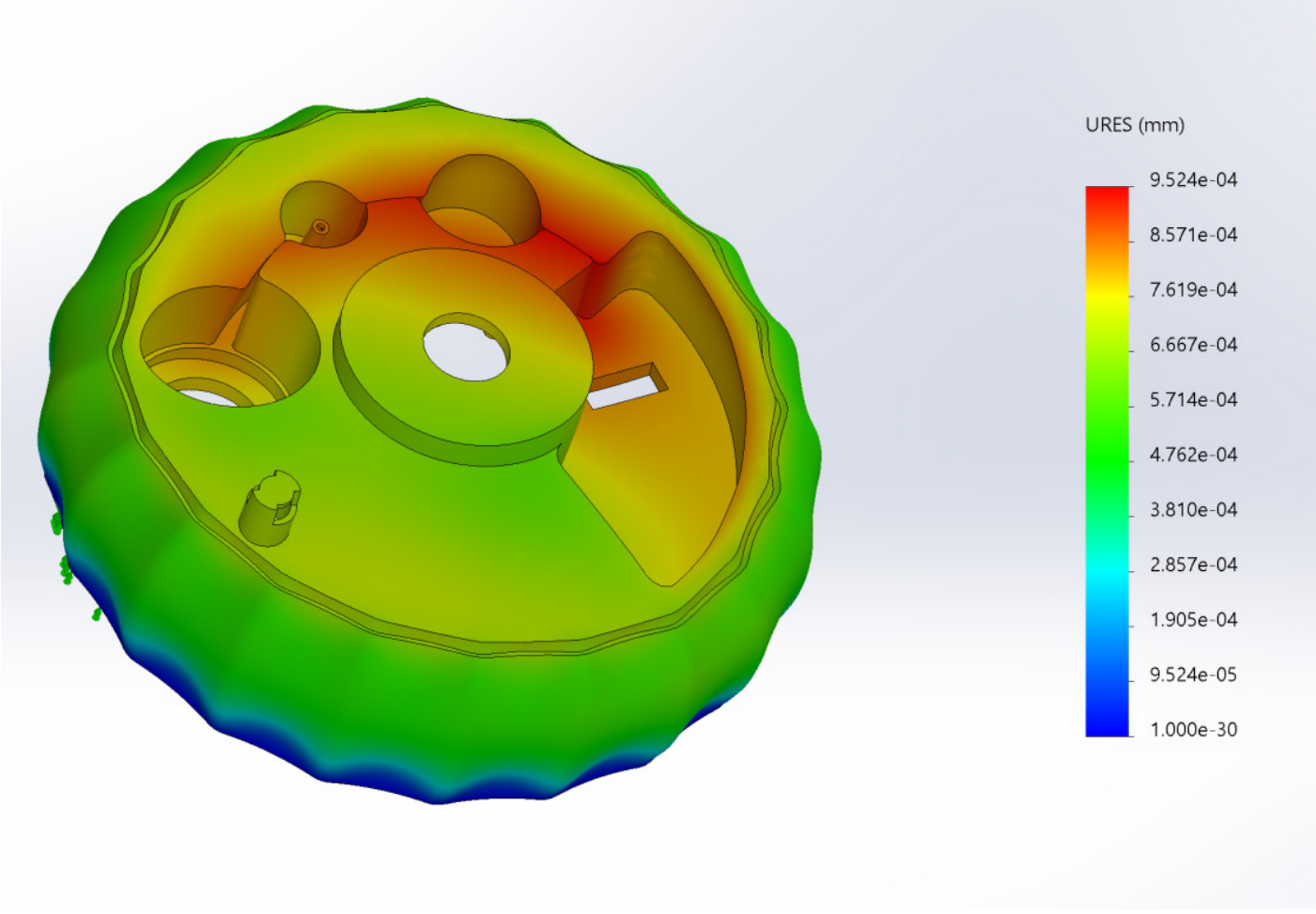
To understand whether our device can withstand external forces, we carried out a FEM analysis by using SolidWorks Simulation.First I used the gravity of the water in the tank 20.45N added to the force surface of the tank. Therefore, by multiplying it by safety factor 1.2, we get approximately 24.54N. If the deflection is less than 2 mm, it can be considered a welldesigned part. FEM analysis shows that the maximum deformation of the water tank is 0.4744mm, so the thickness of the tank 2mm as well as ABS can meet the existing use requirements.

Image 138.
FEM analysis of water tank



For the analysis of the humidifier base, I added the gravity of the water and the gravity of the tank to the force surface of the Base shell, by multiplying it by safety factor 1.2, we get approximately 28.86N. and the FEM analysis showed that the maximum deformation of the Base shell was 0.0009524mm, so the thickness of the Base shell 2mm as well as ABS can meet the existing use requirements.

Image 139.
FEM analysis of base shell



6.7 Calculation of Cost

In performing the costing, I divided the parts of the product into two categories: manufactured parts and purchased parts, and assumed that the production volume of the product was 1e6.

When calculating the manufactured parts, I took into account the weight and volume of each component, the price of materials and the price of the manufacturing process, set the parameters of the manufacturing process according to the dimensions of the different components, and finally obtained the unit price of each component and the overall price of all manufactured parts as 5.05EUR.

Component	Weight	Volume	Material	Unit price	Process	Total Price
Water Tank	367g	343cm^3	ABS	1.5EUR/kg	Injection Molding	1.3 EUR
Base Shell	322g	301cm^3	ABS	1.5EUR/kg	Injection Molding	1.1 EUR
Lid	132g	126cm^3	ABS	1.5EUR/kg	Injection Molding	0.7 EUR
Flower	67g	62cm^3	ABS	1.5EUR/kg	Injection Molding	0.4 EUR
Connection.1	2.1g	2cm^3	ABS	1.5EUR/kg	Injection Molding	0.2 EUR
Connection.1	6.3g	6cm^3	ABS	1.5EUR/kg	Injection Molding	0.2 EUR
Float Hinge	3.9g	3.7cm^3	ABS	1.5EUR/kg	Injection Molding	0.15 EUR
Shaft	102g	73cm^3	POM	1.2EUR/kg	Milling	0.3 EUR
Gear	9.4g	6.7cm^3	POM	1.2EUR/kg	Milling	0.15 EUR
Rubber Bottom	17g	14cm^3	Polyurethane	1.2EUR/kg	Injection Molding	0.2 EUR
Shaft rubber	1.56g	1.3cm^3	Polyurethane	1.2EUR/kg	Injection Molding	0.15 EUR
Float	59g	66cm^3	PP	1.0EUR/kg	Injection Molding	0.2 EUR
Total Price						5.05 EUR

Table 12.
Price calculation of designed parts

When performing the calculations for the purchased product, I referred to the unit component prices in the previous section and came up with an overall price of 32.8EUR.

In summary, after taking into account the material cost of the product, the process cost and the cost of the purchased components,
the unit cost of the humidifier is 5.05 + 32.8 = 37.85 EUR.

Component	Unit Price
Linear actuator	12 EUR
Oscillator	4 EUR
Humidity sensor	2 EUR
Fan	5 EUR
UV-C lamp	6 EUR
Rotary Angle Sensor	3 EUR
Float ring	0.8 EUR
Total Price	32.8 EUR

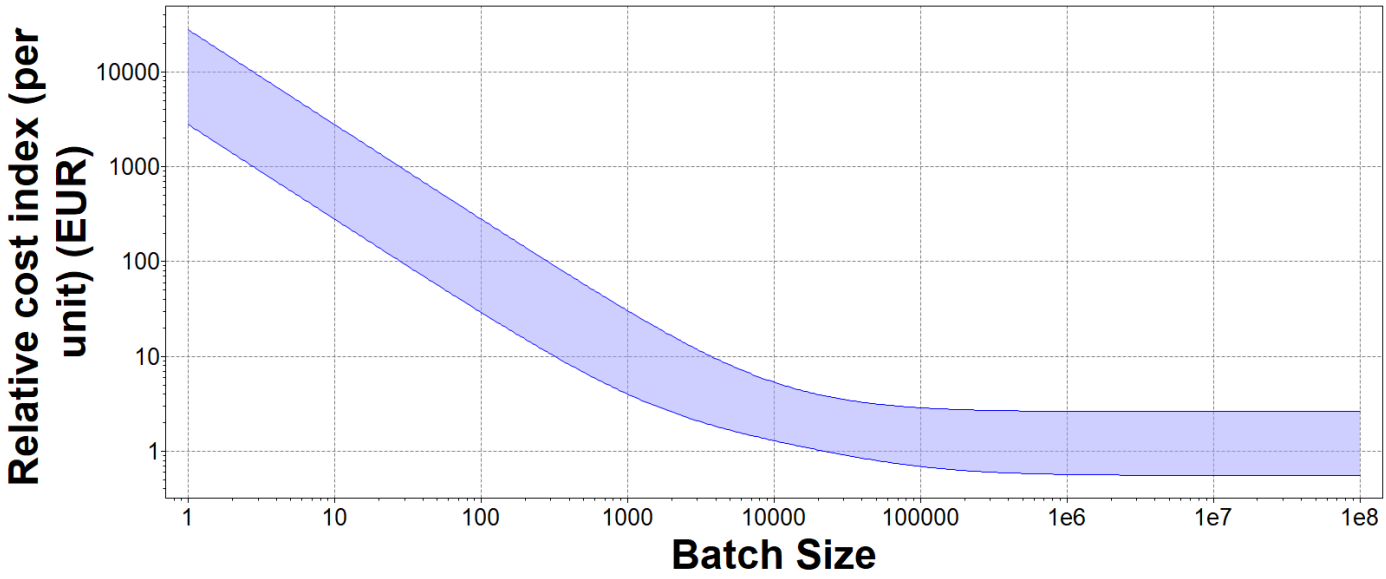


Table 13.
Calculation of the price of purchased parts

Table 14.
Table of the relationship between unit price and size of injection molding process

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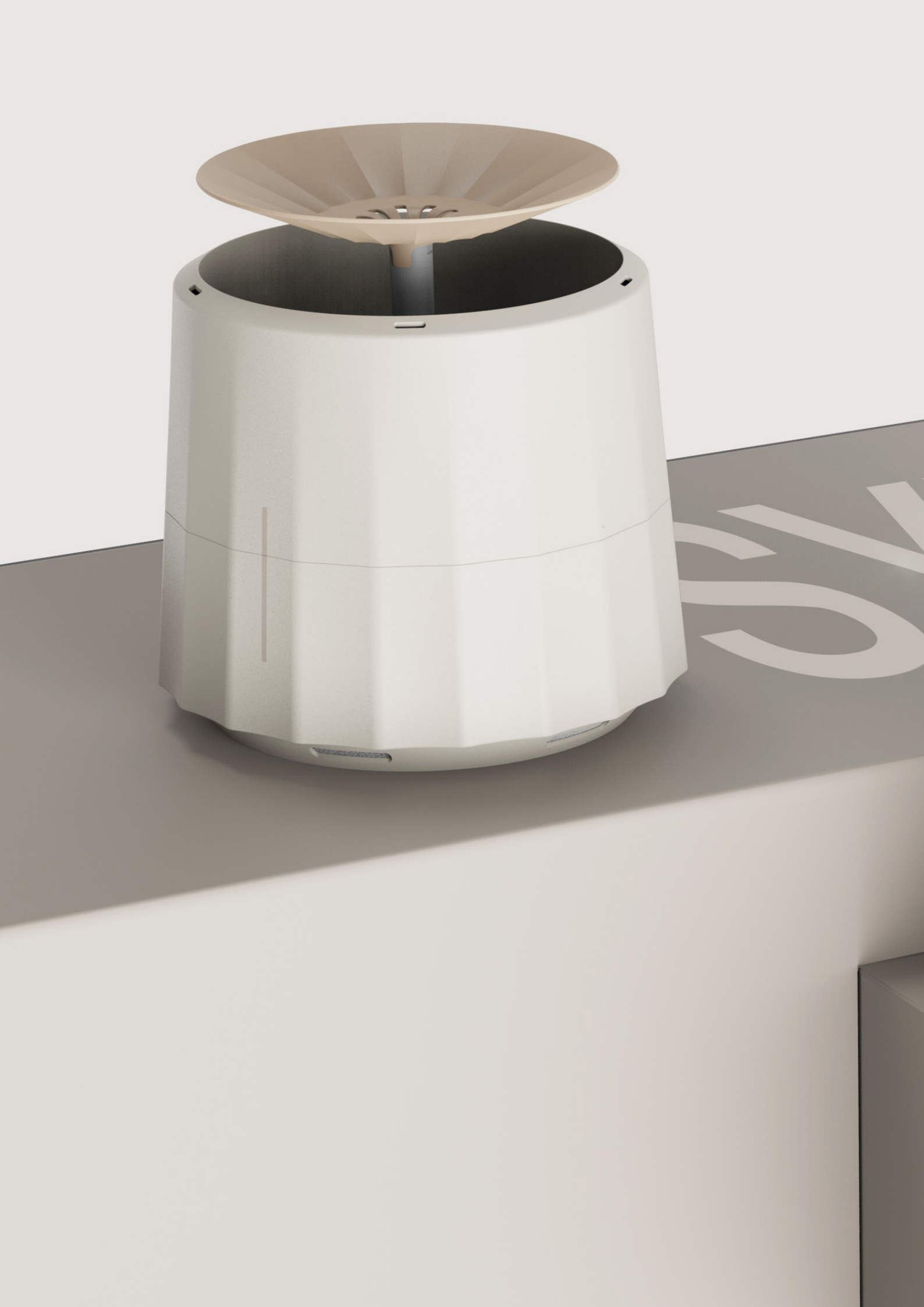

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