

# Design Research on Self-service Medical Apparatus and Instruments Aiming at Elderly Users

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**Abstract.** With the development of China's society, the aging population has become a more serious problem, and old drift family has come to a common phenomenon. These old parents who live in lonely big cities are away from their own home and are cut from the original social support system as they have to take care of their children's children, thus causing the loneliness of their mental life. And at the same time, they cannot travel conveniently like the young. What is even worse, some old parents are suffering from sugar (urine) disease, hypertension, heart disease and other chronic diseases, as a consequence, the high medical expense as well as their health condition cannot be monitored 24 h a day are causing headaches for them as they have no accessibility to local medical insurance. So, the research on the design of self help medical instrument products aim at the old is of great importance.

In this paper, the severe aging population is set as the background. Then first and foremost, this paper studies the mental state, physiological state and the present status of the products aiming at aged people in domestic market, and analyzes the existing problems of the products for aged people, including slack development of the market, simplicity of service and the randomness of industry's standard; second, based on theoretical knowledge, this paper analyzes the way old people studies, recognize the world and memorize things by referring to literature materials, also this paper analyzes the condition of using scientific and technological products of the old; at last, this paper analyzes the psychological and physical requirement of old people toward self help medical device based on survey and analysis, summarizing a more systematic design method which includes practicability, emotional, accessibility and security.

This paper starts from a people-oriented point, targets the seniors as the target group and studies the design orientation of self help medical devices from a variety of aspects, trying to integrate the special requirements of old people with design elements of this kind of product and combining them with the design of the products to optimize the design of our products. These idea aims at reducing the hidden danger caused by wrong operation and makes it danger-free, giving them care, improving their well-being, leading a more comfortable and heather lifestyle and realizing the care for old citizens. Also, this paper also aims at finding a design method of this kind of product, summarizing the principles of design, breaking the original design patterns of self help medical devices and providing an example for designers.

**Keywords:** The aged · Self-service medical apparatus · Physiological needs of aged people · Psychological needs of aged people · Design principles

## 1 The Development Status of Self-service Medical Equipment for Aged People

Currently, China is already one of the country that mostly affected by aging trends and has the largest population with aged people. With the improvement of life quality, people did enhance their consciousness on their health and the self-service simple medical measuring instrument and health recovery instrument are becoming the development trend for future. The US *Fortune* magazine has taken the self-service medical equipment as one of the industries that will have the fastest-growing business in coming 10 years. Even though the market related to self-service medical equipment in China is still in the embryonic stage, according to current situation in China, it shall inevitably be the emerging sunrise industry in China.

### 1.1 The Sluggish of Market Development

If we say that at present there's quite few R & D related to self-service medical equipment within China, then the self-service medical equipment designed for aged people shall be very little. Currently, the R & D made on such kind of product depends on the influence of those important factors such as technology level etc., this shall be a procedure with long investment cycle, huge capital demand and higher risk, thus domestic enterprises did not pay attention on its R & D, and few investment has been made on the R & D accordingly, without enough enthusiasm, it's still in the stage that taking imitation as their main task.

### 1.2 Randomness of Industrial Standards

Currently there are many similar products in domestic market of China, they are mainly the products in middle/ low level and lack of independent R & D and innovative ability; this makes the design of such product is not reasonable, with quite little technology content and lower liability, weak practicability. Thus it also results in the non-standard state of the industry in R & D of such kind of product, and the whole industry is also in the chaos.

## 2 Living Conditions of Aged People

Through close observation to investigate the living conditions of some aged people in depth, the three representatives would be as investigation for total three units with fifteen people of each group. Such three cases that representing the living conditions and the common problems existed in most of aged people:

**Case 1.**

<b>Observer</b>	Author	<b>Observing place</b>	Daye city	<b>Observing time</b>	Nov. 2015
<b>Observation subject</b>	Grandma Yu	<b>Age</b>	70	<b>Health condition</b>	Old disease with leg ache
The old woman has both the visual and auditory degradation gradually and the old disease with leg ache, both her son and daughter is worked locally, and the old woman was living with her granddaughter separately, has not further trouble to take care of their basic life and daily life.					
<b>non-verbal behavior observation</b>					
<p>1、 Due to the old disease, grandma Yu cannot burden the walk for a long time and in a long distance, sometime the author did also ferry her granddaughter with the old woman together, and Grandma Yu often bent down to hold her knees with hands for rest, the author did want to help her, but Grandma Yu refused tenderly.</p> <p>2、 Occasionally in afternoon, Grandma Yu took some sewing work under sufficient sunshine wearing her presbyopic glasses, the author also helped the old woman to start the sewing work, and the old woman then gave some jokes like “I’m old enough and more disabled, even cannot put a thread through a needle”.</p> <p>3、 While chatting with the old woman, the most concerned contents are the son and daughter of the old woman. She did also tell one thing that one day she come out of home for activities, when coming to the street, suddenly her mind was empty and even cannot find the way home.</p> <p>4、 Once the author came to the home of Grandma Yu for a visit, seeing that Grandma Yu was using the washer to clean the clothes, but trying too long a time without any progress.</p>					
<b>target behavior analysis</b>					
<p>1、 Due to her old disease, the old women has the mobility trouble and may need the auxiliary products - by refusing the help provided by other people, it just reflects her strong mentality with self-reliance.</p> <p>2、 Because of the impaired vision, the old women has the trouble in self-care ability and her speech also shows some negative tendencies.</p> <p>3、 The largest thing the old woman wanted is the care from her children surrounding herself, and there’s the brain degeneration symptoms with the old woman, it may also affect her daily life accordingly.</p> <p>4、 For the newly sprouted things, especially the usage of high-tech product, the old woman has the degradation on learning ability and with weakened operation ability.</p>					

**Case 2.**

<b>Observer</b>	Author	<b>Observing place</b>	Wuhan City	<b>Observing time</b>	Nov. 2015
<b>Observation subject</b>	Grandma Li	<b>Age</b>	72	<b>Health condition</b>	Old disease with waist ache
Grandma Li was widowed at her middle-age and cultivated his only son alone. Now she’s lived with the couple of his son in metropolis and retired at home to help take care of her grandson in nursery school.					
<b>non-verbal behavior observation</b>					
<p>1、Grandma Li has the old disease with waist ache, and the couple of his son was always busy for their job and only persuaded their mother to see the doctor in hospital alone for several times; but the old woman did think that it’s not worthy to spend money in the hospital for such small pains and aches, and has been reluctant to go to a doctor.</p> <p>2、Occasionally Grandma Li will go back to her home town for short term stay, the couple of her son has also bought an Apple mobile phone for communication, but Grandma Li did rarely use the mobile phone.</p> <p>3、During the stay in her home town, she usually made the appointment with her old friends to play the flute in the small pavilion of the local park during spare time, when feeling tired she may talk with the old friends, once talking about the couple of his son, her speech was always fulfilled with praises and the expression with satisfaction.</p>					
<b>target behavior analysis</b>					
<p>1、The old woman has the old disease but was reluctant to go to see a doctor due to no correct consciousness of cure &amp; treatment and not willing to spend money on the disease, thus delayed the treatment time.</p> <p>2、The old woman has the lowered sensitivity on the high-tech products, and the degradation on the ability of learning, cognition and operation.</p> <p>3、The old woman may also need her own social circle, so as to fulfill her psychological demand, at the same time, although the old woman was proud of her children, but eagerly want to be accompanied with her children.</p>					

**Case 3.**

<b>Observer</b>	Author	<b>Observing place</b>	Day City	<b>Observing time</b>	Nov. 2015
<b>Observation subject</b>	Grandpa Xu	<b>Age</b>	75	<b>Health condition</b>	Myocardial infarction, cataract, hypertension
<p>The old man was lived with his wife together, some of their children worked locally for business and some other worked in the field; they are quite busy to work at ordinary times and cannot take care of the aged couple accordingly.</p>					
<b>non-verbal behavior observation</b>					
<p>1、The author has spent time to have the meal with the old man, seeing that his hand shaken terribly and can hardly clip the vegetables. The author has persuaded him for several times to change the chopsticks by spoon, but failed finally.</p> <p>2、The old man has the disease of hypertension, while the weather is good he may have the outdoor walk along the pedestrian, sometime due to his limited vision with the cataract, he even cannot help falling down in case of small pits or obstructions on the pavement, the author intended to support him, but he did refused.</p> <p>3、Occasionally his children did go back home to see the old couple, even in the cold weather the old man will wake up early to buy vegetable and meat from outside, urging his old wife to prepare the delicious meal for their children.</p> <p>4、The granddaughter has given a blood pressure gauge as the gift to Grandpa Xu and spent long time to teach her grandpa using it, and asked her grandpa to insist the daily measurement on his blood pressure; usually the old man readily promised but when his granddaughter left, the old man still pushed the blood pressure gauge aside again.</p>					
<b>target behavior analysis</b>					
<p>1、The old man has the motor function degradation, cannot use the chopsticks more conveniently and flexibly but refuse to use the spoon with convenience, this shall be the psychological characteristics of the old man that being not satisfied with the old status.</p> <p>2、Due to his chronic disease such as the hypertension, the old man needs to be examined regularly, and his walk is also impacted according to the limited vision, but he still refuse to have support from the others, this can prove the psychological demand of self-reliance inside the mind of the old man again.</p> <p>3、While his children returned home, the old man was really happy and started to prepare the meal even earlier; being lack of the company of their children, the old man may form the empty and lonely psychological; the occasional return of his children may let the old man feeling extremely satisfactory.</p> <p>4、The granddaughter has given a blood pressure gauge as the gift to Grandpa Xu and spent long time to teach her grandpa using it, and asked her grandpa to insist the daily measurement on his blood pressure;finally the old man still pushed the blood pressure gauge aside again. This indicates that the old man shall have the degradation of cognition ability and learning ability, and cannot accept the complex operation methods easily, even form the rejection feeling.</p>					

## 2.1 The Physiological Characteristics of Aged People

Aging is the inevitably spontaneous process of the creature as time goes by, it's the unavoidable and irresistible natural law for each creature, being the complicate natural phenomenon, it shall represent as the degradation of the structure, recessed function, and the decline of adaptation and resistance.

While the human body entering in the aged stage, all the function of their body may generate the obvious recession, although the pace of such process shall vary with each individual, but it's really unavoidable for every one, it means the aged people shall have the degradation on the ability to adapt to the endogenous and exogenous environments.

Through the methods of reviewing the literature, investigating some of the survey targets and asking relative researchers etc., the author did summarize the physiological status change occurred in aged people as following:

**Aging in the Form.** While being the aged people, first of all the most obvious change is aging in the form, usually it represents as that the hair and beard becoming white and loosen, easy to break off; the skin losing its elasticity and the smooth lustre, and easy to generate the blemishes and wrinkles; the gum tissue becoming in atrophy, and the teeth becoming loosen even falling out; even the aspect characteristics in some aged people such as hunching over, etc.

**The Function Decline of Sensory System.** Human body's sensory organ system mainly include the sense of vision, hearing, smelling, touch and taste, etc. The physical function of aged people is fickle, with the increase of age, especially on the sensory organs, it shall represent the obvious degradation phenomenon relatively, and impact the life-independent of the aged people to varying degrees. Such as the degradation of the adjustment function in the sense of vision and hearing shall bring great confusion on the life of aged people. According to the newest statistical data, more and more aged people have the eye disease, thereinto, so many aged people have the so-called hyperopia on medicine, that is the commonly referred presbyopia; and some other aged people were deeply influenced by the cataract disease accordingly. The decrease of hearing function shall also be the common problem existed among most of the aged people, so that the aged people usually gave the speech loudly, or hear the voice in closer distance or the higher decibels to complement their deficiency in hearing. The degradation of sensory ability enabled the aged people being not adapted to the environment, meanwhile the chronic degenerative diseases are also easily occurred.

**Function Decline in Motor System.** Along with the increased age, the aged people may act even slower with uncoordinated movement and bad balance performance; and the aged people may also have the lower speed on learning the new things gradually, their operation ability and reaction speed shall be decreased accordingly, all these are caused by the tissue cell aging and declining of the aged people. So during the common daily life, the aged people may always need supporting tools to relieve such kind of physiological defect.

**Decline in Brain Function and Forgetfulness.** One of the most common dysfunction along with the aged stage is the decline in brain function and the decreased memory and cognition ability. These shall be the most common symptoms occurred in aged people and they can easily make the aged people with the feeling of “lack of strength to do what they really want”. Usually it represents as the increased memory, preoccupied and pointless thinking contents, inattention, fatigue and amnesia, being good at remote memory and weak at the recent memory etc. These are caused by the reasons such as the decrease in the number of brain cells, brain atrophy etc.

**Decline in Adaptability.** With the loss of functional metabolism, the aged people may have even poor adaptability for the change of internal/ external environments, it usually represents as the decreased immunity of aged people and the declined sensory ability to the external environment and higher occurrence of any kinds of diseases in both small or large scale. Thus, the supervision made on the body of aged people in all kinds of healthy indicators shall be very important accordingly.

## 2.2 The Psychological States of Aged People

Being in the aged time, there shall be various problems coming with human body, such as the obvious decline in the variety of body function, the troubles of all kinds of diseases in both small and large scale, these enables their adaptability to the external environment being decreased accordingly, and irresistibly accepting the problems such as the transform of their identify and social status shall bring changed in the psychological states of the aged people to the different degree. Through viewing literature and investigating the survey targets, the author concluded the psychological states of aged people in following two categories:

**The Changes of Psychological States Induced by the Physiological Dysfunction of Aged People.** Being limited by physical function, the aged people can easily have the bigger psychological gap, so as to cause the emotional instability and poor self-control ability and the depression influenced by negative emotion, being prick, anxious and depressed, with inferiority autistic and often with negative speech and behavior, etc.

**The Changes of Psychological States Induced by the Changes in Life Style of Aged People.** The aged people usually have had the rich life experiences and formed the inherent model and habits; and all those models and habits have been reinforced among the social practice for so many years. The ritualized concept of aged people enables them hardly accepting the new things, so that hardly adapt to the changes of their living conditions.

Therefore, most of aged people usually refused to admit that they're old, some of them still have the confidence on themselves due to their own inherent models and concepts, some other aged people are worried to be their children's burden because of their old age and the declined physical function, then they even are eager to excel others especially.

### 3 Demand of Aged People

Relative functional characteristics	Behavior characteristic analysis	Matching demand information
Aging in the form	Wrinkle emerging, white hair and beard, loosen teeth and loss of teeth	To adjust own mood; with more communication and exchange.
Decline in visual function	Obvious degradation in vision; with limited vision, the self-independence ability is impacted, resulting in the loss of security feeling.	To see the doctor in time, by using the supporting tools to fulfill the visual demand.
Decline in hearing function	Sharp decrease in hearing, having trouble to communicate with the others, resulting in the character trait such as introversion, less speech, autism etc.	By using the auxiliary tools to fulfill the hearing demand, having more communication with the others, adjusting own attitude.
Decline in motor function	Slower movement, uncoordinated movement, the lowered reaction speed	By using auxiliary tools to ensure their own movement.
Brain function degradation	Forgetfulness, amnesia, decline in cognition ability, the severe in dementia, the decreased ability to accept the new things, seriously impact daily life.	More communication, more contact with the new things, to relieve the amnesia symptoms accordingly.
The lowered adaptability	Cannot adapt or hard to adapt to the changes of internal and external environment, ill at ease	To adjust the attitude, to see the doctor in time.

#### 3.1 Physiological Needs of Aged People

From the abstraction of above tables, it can be seen directly that, due to body's aging and declines in all kinds of system function, aged people shall have the weakened self-independence ability, even with the chronic diseases, and their children couldn't be with them for necessary care, the security potential has been already the important problem among the life of aged people. Thus, the product design for aged people shall take the users of aged people as the starting point, to fulfill the demand that complement the physiological defects due to aging and the inconvenience due to unattended aged people. Such as the magnified display, vocal operation method and simple operation interface etc.

#### 3.2 Psychological Needs of Aged People

The psychological stages of aged people is both fickle and sensitive, the designed article aimed to take the aged people as the center shall enable them willing to use at first, so the design concept shall be determined according to the using and emotional psychological need of aged people.



The using psychological is to take that the designed article fulfilling the physiological need of aged people and complementing the physiological defect of aged people as the premise. For example, with the increased age, the hearing range of aged people may become smaller and they may take the hearing auxiliary products as reference, first of all the willing of aged people to use such auxiliary tool shall be ensured. According to survey, it shows that, being affected by negative emotion, most of aged people are unwilling to admit that they're old due to their degradation of physiological function, and they are also fear of that being commented as the old, thus some of aged people are not willing to use the auxiliary tools to complement their physiological defect; from this, in order to fulfill the using psychological need of the user, the Danish designer developed the micro hearing AIDS, due to its delicate and compact appearance, it can be easily wore in the ears to achieve the invisibility effect.

The emotional physiological need refers to that the majority of aged people shall be affected by the negative emotion and acted with negative thoughts and deeds and reject the medical equipment and products, and the aged people shall have stronger desire in the care on themselves as their age increased. Thus the emotionalized design shall be incorporated in the aspects such as interaction method, human-computer interface and appearance design etc., in order to fulfill the emotional need of aged people.

#### **4 The Elderly Medical Equipment Product Research Analysis**

The above-mentioned products as self-service medical machine are fit for the old and takes tracing pattern of big lead angle, mellow and rigorous geometrical morphology as the principle things from the appearance aspects. Big lead angle and mellow pattern with loveliness sense bring the appetency to buffer the mental pressure of users and improve the fear mood for the cold medical machine without rejection sense. Products appearances of geometric shape could bring sense of brief, rigorous, prudent and order but the appearances would be ordinary if the details are not dealt with very well (Figs. 1, 2, 3 and 4).

From color aspects, most of products could appear colorless serious –gray and white, and low-purity or high clarity color serious. Gray and white could give the peace and pure sense to reconcile with other colors without color bias. Low-purity or high clarity color serious could give soft visual sense as neutral color to be accepted by the old, for example, the light blue color serious as neutral color could be always used in the Siemens medical machine to butter the anxiety mood and give the soft sense.

From the materials aspects, the medical products used for the old are made of plastic materials to make feel softer and safer except the powerful plasticity.

From the operational interface aspects, the operational interface could be divided into display area, control area as the example of blood glucose meter. The display area focuses on the big screen and high contrast colors to meet the visual requirements for identification of the old. The control area focuses on the one-button operation to be learnt and used by the old, and the products creative parts of control area to make the form understand and identify for the user without mistaken or incorrect operation.



Fig. 1. .



Fig. 2. .



Fig. 3. .







Fig. 4. .

## 5 The Design Principles of the Self-service Medical Equipment and Product for Aged People

**The Principle that Taking the User of Aged People as Center.** First, the product R & D design for the self-service medical products aimed to the user group of aged people may require the industrial designer to set up the design concept that taking the user group of aged people as the center, insisting in the service & design principle of people first. As the healthy condition and aging status of aged people vary from each other, with the comprehensive knowledge of and understanding the characteristic for aged people- such a special group based on in-depth investigation, it shall abstract the demand information from the user of aged people and implement them into the R & D process of the product, such as the process of research, sorting, design, production and sales etc., thus it can only design the self-service medical product that really meet the demand of aged people.

**The Principles of Learnability and Usability.** The decline of the various physical function among aged people, such as slow response and movement due to motor function decline, the forgetfulness, these result in the decline of the cognition and learning ability of aged people, and it's even hard for aged people to accept the new

State	Brand	Product	Characteristic analysis
China	Sannuo		<ol style="list-style-type: none"> <li>1. Mellow geometrical morphology appearance</li> <li>2. Division for control area and display area by color parts.</li> <li>3. The design of embossing touch key focuses on the products but is uncomfortable for the old owing to small key.</li> <li>4. Grounding color and black for grey display area has lower font contrast that could not be identified by the old.</li> </ol>
America	Johnson		<ol style="list-style-type: none"> <li>1. Combined curved geometry appearance of tracing pattern shows its delicacy.</li> <li>2. The display area with big screen and white background with black text could be easy to identify for the old.</li> <li>3. One touch key is easier to be learnt and used, and embossing touch grain is more comfortable to be operated.</li> <li>4. The technological process of rubber bounding the sides is avoided the slipping and falling.</li> </ol>
Japan	Kyoto		<ol style="list-style-type: none"> <li>1. Curved geometrical morphology appearance</li> <li>2. Small screen could not be identified by the old.</li> <li>3. It could be automatic controlled without touch key to decrease the mistaken operation.</li> </ol>
Germany	Roche		<ol style="list-style-type: none"> <li>1. Curved geometrical morphology appearance</li> <li>2. Big screen could be identified by the old.</li> <li>3. Division for control area and display area by color parts.</li> <li>4. Touch key icon is used of the common icon to insure the operational information and feedback with meeting the users.</li> </ol>

things. The principles of learnability and usability refer to that taking the user as the center, to fulfill the need of user's inherent thinking model and habitual actions etc. For example: the simple operation method; by enhancing the closer connection between production controller and the product functions, to get the match between controller and function more easier to understand; by guaranteeing the user to receive the feedback from production function and commonly-used information & concept even better, to enable the user spending minimum effort to achieve the maximum effect. Therefore, during the R & D process of such product, the principles of learnability and usability shall be necessary.

**The Universality Principle.** The universality principle for production design refers to that the design objects is all the people, to enable every one using the products fairly, flexibly and conveniently. The user of aged people shall be the vulnerable groups, the modern design initiates to insist on the universality principle, a good design can be used either by the vulnerable groups, or all of the people, thus it may require the designer to make the full consideration on the factors of product and environment and get user-oriented to the largest extent. Even during the using peak the barrier-free lavatory in high speed railway station is also rarely used by people, such design exists in name only, that is because that the design has separated the part of user from common people and cannot assure each user to be treated equally. Thus, for the aspects of human-computer interface design, visual information of the product and its size, they shall both fulfill the special need from the user of aged people, and consider of the using experience of common people.

**The Emotional Principle.** The emotion shall be human nature, it's in front of the consciousness and thinking and determines the first impression about the people. The communication between human and product is taking the product modeling, function and operating action as the carrier, during the usage of product, the user may generate the physiological and psychological reaction with different experiences and emotion, while the product fulfilling the demand of the user in daily life, it can also fulfill the spiritual demand in higher level. Relevant data show that the aged people mainly generate the negative emotion due to physiological function and life style, their need for esteem and respect, independence is increasing accordingly. While developing the new product, it shall relieve the negative emotion such as the sense of loneliness and frustration of aged people through the media like product modeling and operating action etc.

**Principles of Safety and Reliability.** With the decreased physiological function, the movement speed, memory, response ability, sense of vision, hearing and touch etc. of aged people may be declined in different levels respectively, while using the product, due to incorrect operation, the slow response speed etc., it may cause the potential safety hazard accordingly. Therefore, the factors for product's safety and reliability must be emphasized, thus it may require the designers to make the overall prediction on for the environmental status that may cause the safety potential during the development of product, and make the effort to eliminate unsafe factors through the design, such as the safety of product materials, the feasibility of product operation method, the reliability of product function, etc.

## 6 Conclusion

The self-service medical equipment for aged people shall be the development trend for future, the industrial designers shall pay attention to the independent R & D of product, to combine the special demand of aged people with the design elements of such kind of product and incorporate them into the product accordingly. During the R & D process of product, to insist and implement the principles of that taking aged people as center, the learnability and usability, universality and emotional principle and the principles of safety and reliability, to enable the product fulfilling the demand of user for daily use meanwhile fulfilling the emotional demand of user, to enable the user feeling the humanity care during using the product, and expect the barrier-free use of the product for each user, guiding them to the comfortable and healthy living conditions.

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