



Research on Kansei Engineering System Establishment for Elderly Product Design

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Abstract. The problem of aging has become an important issue in today's society. It is the social responsibility of scholars to study into it. The purpose of this study is to find out elderly's Kansei needs based on the living conditions of different regions in China. Through an investigation of the living habits of the elderly over 80 years old, the requirements of the design of the elderly products are analyzed. According to the analysis of the connotation and extension of the elderly living habits, the preferred Kansei image is sought, and corresponding design elements are extracted. A system that derives the preferred Kansei image with appropriate design elements is established. In this paper, Kansei Engineering research method is used to investigate the visual, auditory, perceptual and behavioral responses of the elderly and then establish a Kansei Engineering Forwarding System with Kansei adjectives database, design element data base and corresponding logical deduction rules. First, we studied the awareness, personality, aesthetics, diversity, happiness and comfort feelings of the elderly. Followed by interviews and questionnaire surveys to acquire elderly's physiological and psychological characteristics, lifestyle and use environment of daily products. Then an experiment was carried out to measure elderly's Kansei preference and to identify the corresponding design elements. Finally, a Kansei Engineering System for new design patterns in line with the elderly's Kansei preference is established. And the product design and development for the elderly can be carried out with the system. According to the research results, the above-mentioned forward Kansei Engineering System that transforms Kansei image into specific design elements to enhance the experience of the products pays more attention to the Kansei preference of elderly users while pursuing product quality. Hopefully, the elderly people can feel the Kansei value of the design and lead a creative life.

Keywords: Aging · Hybrid Kansei engineering · Image · Product design

1 Introduction

1.1 Background and Purpose of the Research

Research of elderly product design has been made in each field. As science and technology progresses, the different interaction modes and information arising from elderly conceptual design are also Kansei elements that must be mastered by designers, which is also a design direction of high-tech industry in recent years. At present deep

researches of social state and environment of ageing have been made in the profession of product design. However, the research and application of image terms of elderly Kansei is not mature and deep enough. This paper aims to find out living states of the elderly which are varying from place to place and transform the Kansei of elderly group into design elements. The research field of “Kansei engineering” focuses on exploring the mutual relations between “people” and “objects”, which opens a new way for exploring more Kansei researches from the perspective of engineering. Moreover, for designers whose work is to create “objects”, Kansei engineering is a technology to “transform the Kansei or images expected by people into design elements”, survey the factors of elderly older than 80 such as living habits and analyze the feelings and demands of elderly as the main appeal. Through analysis and deduction of connotation and extension of living state of the elderly, factors of Kansei elements are created and the Kansei image language is sought. Kansei factors are derived to the system of conceptual characteristics of design.

1.2 Scope and Methods of Research

By means of Kansei Engineering System, this paper integrates perceptual experience of users such as vision, hearing and touch into the product development design, which includes:

1. Assisting to promote the conceptual design capacity of products;
2. Establishing an information system concerning product design.

The research will explore the connection between the Kansei of elderly and product design elements through the sensory systems with frequent interaction with information products such as vision, hearing, smell, touch and taste of elderly and establish the theoretical foundation for applying senses and Kansei engineering in the information products in the future.

2 Kansei Factors of Elderly

In the 1980s, Dr. Herbert A. Simon, a professor with Carnegie Mellon University of the US and a winner of Nobel Economy Prize in 1978, argued that the development of three emerging academic fields, namely “design science”, “psychology” and “information science” at that time would bring a chance of another start to the engineering science, and therefore advocated developing “humanity science” [1].

As science and technology progresses, the media for passing information to the elderly keep renewing. Different information creates different modes of interaction for sensory organs of the humankind. Accurate data can be acquired through instruments and equipment, which are shown in Table 1.

Table 1. Physical measurement methods of Kansei engineering

Type of sense	Measurement item	Measurement instrument
Vision	Color	Color photometer
	Light intensity	Luminosity instrument
	Eye movement	Eye tracker
	Direction	Protractor
Hearing	Sound intensity	Sound pressure meter
	Sound frequency	FFT instrument
Skin sensation	Hardness	Body pressure distributor
	Roughness	Roughness instrument
	Temperature	Thermometer/Thermocouple
	Humidity	Humidometer
Touch	Weight	Electronic scale
	Speed	Tachometer
	Direction	Compass
	Strength	Electromyograph

The design direction of high-tech industries in recent years is to integrate accurate data into key industries such as people’s livelihood, information, service and communication and stress the feelings, experience and demands of users as the main appeal [2], as shown in Table 2.

Table 2. Survey of physiological characteristics and behavioral response of the elderly

Area/country	Percentage in age structure of the population (%)			Aging index (%)
	0–20	21–65	Above 66	
The world	27	65	8	29.63
Developed countries	17	67	16	94.12
Developing countries	30	64	6	20.00
Japan	13	64	23	176.92
Germany	14	66	20	142.86
France	18	65	17	94.44
The UK	18	66	16	88.89
Canada	17	69	14	82.35
Australia	19	68	13	68.42
The US	20	67	13	65.00
New Zealand	21	66	13	61.90
South Korea	17	73	10	58.82
Singapore	18	73	9	50.00
China	19	73	8	42.11
Malaysia	32	64	4	12.50
Philippines	35	61	4	11.43

3 Analysis of Kansei Image of Elderly

The treatment of Kansei information by the elderly can be discussed under two stages. The first one is the stage of somatic sense, and the second one is consciousness. The treatment of somatic sense and consciousness is mainly differentiated through their time sequence. Usually the former appears after consciousness and is completed in a short time. The cognitive stage occurs through somatic sense. Under the cognitive stage, consciousness integrates all characteristics of somatic sense information to form complete cognitive information before it is applied for designing.

3.1 Analysis of Kansei Image of Somatic Senses of the Elderly

Vision

With the growth of age, our cornea gradually loses gloss and the capability of our eyes to refract lights grows poorer. The function of our iris sphincter muscle declines, which causes our pupils to shrink and the lights that enter our eyes will be reduced. Our crystalline lens will become yellow and turbid. And the visual perception cells of our retina will die and decrease gradually. The declining of a series of our physiological regulation functions will directly affect the changes of our visual acuity, brightness, space, colors and information processing (Fig. 1).

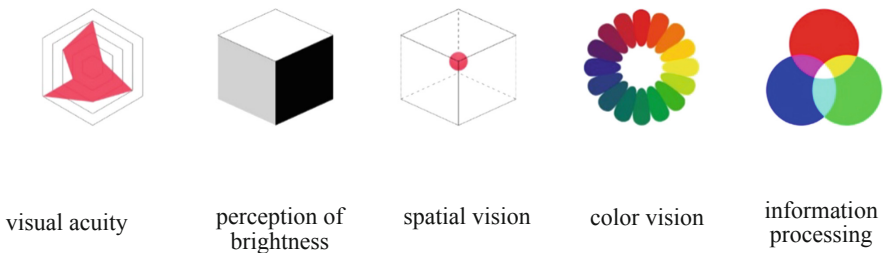


Fig. 1. Schematic diagram of visual perception (Color figure online)

Changes of vision acuity: Taking 20 years as the benchmark, to guarantee the same level of vision, the contrast ratio of target and background is 2 at the age of 60, and the rate of declining will grow faster after the age of 60, and the contrast ratio will reach 6 at the age of 80. Changes of perception of brightness: The adaptability to brightness and darkness will decline to different extents. For an adult, for every growth of 13 years in age, the luminosity required will need to double. Changes of spatial vision: Due to the declining of peripheral vision and visual field, the elderly usually cannot see the objects before their eyes. Since their ability to observe the distance and three dimensions of an object has declined, the elderly cannot accurately identify the distance and height of the object. In addition, due to the decline of their visual acuity, the boundary of the object observed by them will become vague, as a result of which their perception of spatial depth declines. Changes of color vision: Since their crystalline lens becomes yellow and

turbid, the crystalline lens will absorb blue light selectively. As a result, the elderly’s capability to identify blue will decline more significantly than their capability to identify red and green. Changes of visual information processing: The elderly needs a longer time to find out “9” from a matrix of “6”. The interval between two flashing points needs to be long enough for them to identify. That is to say, the capability of the elderly to process visual information such as visual search and visual coding has declined.

Complications and other diseases that occur with the growth of age and impacts of environment are shown in Table 3.

Table 3. Blurring degree of vision of the elderly due to illness

Cause	Low eyesight	Blindness
Presbyopia	√	
Senile cataract	√	√
High myopia	√	√
Age-related macular degeneration	√	√
Diabetic retinopathy	√	
Glaucoma	√	
Keratonosus	√	
Eyeball and optic atrophy	√	√

The visual performance of the elderly declines. According to the research made by some scholar, the minimal acceptable visual angle preferred by the elderly is 0.75°, and sighting distance is 43 cm. After conversion, it is equivalent to a height of characters at 5.62 mm, which can also be found in Fig. 2 “Smallest Identifiable Sizes of Characters for Different Age Groups in JIS Specifications as a reference for you, shown as below.



Fig. 2. Schematic diagram of smallest identifiable sizes of characters for different age groups

Design strategy under impacts of vision: In lighting design of rooms for elderly, reflected light should be preferred and the switch should come with a dim indicator light and a big size to make it convenient for the elderly to find the switch. Particularly at night when the elderly go to toilet, it is difficult for them to find the position of the switch in darkness. If the light directly goes into their eyes, it will be too dazzling for them to see clearly.

Hearing

What happens most commonly is that the elderly has decreased hearing and cannot hear clearly unless we speak louder. The physiological structure of our hearing organ is composed of auricle, auricular media and auricular internal. The auricle of the elderly is filled with piles of hard cerumen. The hair cells in their cochlea of auricular internal and the cells of their auditory nerve passage have declined and died, and the cells of their cochlea receive an insufficient blood supply. All these causes contribute to the declining hearing of the elderly, which is mainly reflected as follows.

Insensitive response to high-frequency sound waves. The pitch of the sounds must be very high: An adult in 30s can hear the sounds of 4 dB with a frequency of 6,000 Hz. Under the same frequency of sounds, for the elderly at 80 the sound intensity needs to be increased by 40 dB or even higher. The selective attention of hearing of the elderly declines. As we know, in “cocktail party effect”, we can neglect other dialogues or noises in the environment when our attention is focused on the speech of someone. As we grow old, our selective attention of hearing will begin to decline.

Design strategy under impacts of hearing: A lot of electronic products come with a voice reminder against any strong and sharp sounds, so as to control the frequencies of sounds within the elderly’s range of audibility.

Kansei image term: They cannot hear low pitch sound and dislike high pitch sound, prefer slow speech and quietness.

Touch, Taste and Smell

It is relatively slow for the elderly to identify things by touching, tasting or smelling. Due to the degeneration of cells in the skin, the touch and temperature feel of the elderly will weaken and their sense of pain will become relatively blunt. In general, due to the ageing of their sensory organ system and the declining of various sensory abilities and functions, they become not sensitive to peculiar smells and their sense of touch also becomes weaker. The quantity of sensitive touch points on the skin of the elderly above 60 years declines, their skin begins to wrinkle and become less elastic, senile plaques appear, glands shrink and sweat glands become less. As a result, the minimal sensory stimuli intensity required for the skin to sense touch need to grow gradually at the old ages. Besides, the elderly’s senses of temperature and pain will become more blunt, so they are prone to bruises and burns.

In 1954, in a psychology experiment conducted by the laboratory of Canada McGill University, the students were asked to put on a pair of specially-made semi-transparent plastic spectacles (to deprive them of vision), cover their hands and arms with paper-made gloves and sleeves (to deprive them of touch) and lie quietly in a special room filled with monotonous buzz (to deprive them of hearing). Generally the respondents could not bear it for over three days. And after the experiment, they felt restless, their attention became disorderly and their thinking was disturbed. They could not think as

normal people did, and their wit also declined to a poor level. The experiment indicates that though senses are a kind of simple and low-level psychological activities, the depriving of senses will surely affect the complex and high-level psychological phenomena such as memory and thinking.

Dimensions of Human Body and Muscular and Skeleton System

The muscular and skeleton systems of the elderly decline, their response becomes slow, their flexibility declines, and the intensity and control ability of their muscles keep declining too. Generally the muscular strength of average people reaches the peak at the ages of 20–30 years and begins to fall later on. The muscular strength of average people at the age of 70 will only be half of that at the age of 30.

For the elderly, the muscular strength of lower limbs is an important stamina factor, which plays a very important role in daily activities (such as walking, going upstairs and downstairs, maintaining balance). According to the researches, the muscles and muscular strength of human body reach the peak at the age of around 20–30. After that, our physical functions will begin to decline slowly. As the number of muscular fiber is reduced and the density of fiber decreases, the skin begins to shrink and the muscular tissue will be changed. As the fat mass of human body grows, the strength, elasticity and tone, moving speed of skin will decline gradually.

Muscular strength refers to the ability of muscular tissue to make a single contraction against a resistant force. Muscular endurance refers to the maximum ability of a muscle group to contract continually. The muscular strength and endurance will decline distinctively due to old age and lack of movement. William (1999) pointed out that the age is a main factor for the reduction of muscles. Muscular strength declines gradually with ageing and lack of exercise, which will lower the mobility of human body, lead to movement disorders and increase the chance for the elderly to be harmed in accidents.

The reduction of muscles is most common in the normal process of ageing, which is not caused by singular factor, but caused by the reciprocal effect of two systems, namely, nerve and muscle, due to the reduction of body movement. As we grow old, the number and size of our muscular cells will fall. The distinctive fall of muscle mass happens at the age of around 50. Due to the reduction of muscle mass, muscular strength becomes poor. A proper amount of movement may improve our conditions due to the reduction of muscle mass caused by ageing and enhance our muscular strength or endurance. Meanwhile, Tominaga Tesuo (2000) measured the changes of muscle mass with ultrasound and discovered that muscle mass was lost naturally by 3–5% in every 10 years after the age of 25. The mass of knee extending muscle, knee bending muscle, dorsum pedis bending muscle, pelma bending muscle, elbow extending muscle and elbow bending muscle at the age of 70 is respectively 60%, 80%, 70%, 67%, 76% and 87% of that at the age of 20, which is because of the reduction of muscular fiber in the motor unit.

Kansei image term: The strength declines when muscle contracts, which affects our mobility.

3.2 Analysis of Cognitive Kansei Image of the Elderly

Cognitive functions refer to our mental abilities to understand and reflect objective things, such as attention, imagination, learning, memory and logical thinking. With the cognitive ageing, the elderly's duration of attention is affected, their ability to receive information declines and their memory grows weaker. The weakening of memory worsens some logical inference ability of the elderly. As a result, their analysis of senses becomes slow, it takes a longer time for them to move and respond and the elderly will be deprived of the ability to perform daily life activities and cannot live independently.

Attention

Our living environment is filled with a lot of stimuli, which will compete for our attention. Attention is an ability to focus on specific stimuli. When we pay attention to specific stimuli, we will gain perception, while the stimuli beyond our attention will be vague and neglected.

In the era of Internet fragmentation, all of us find it difficult to focus our attention. That is because various stimuli come in succession, we have to divert our attention. However, for physiological reasons, the elderly's attention becomes blunt and cannot last long, without the accuracy and speed required for the control of attention in their youth.

Kansei image term: The elderly's attention is also characterized by inertia. It is quite difficult for them to neglect the irrelevant or disturbing information that is retained in their work memory.

Memory

Memory is the foundation for the humankind to learn different behaviors and a mental phenomenon in which information is saved after being received. Our memory is mainly classified as sensory memory, short-term memory and long-term memory. Sensory memory is the retaining of sensory stimuli in a short time. For example, we can observe still images of 24 frames/second in a film as successive images. Short-term memory refers to the memory system which can save a small amount of information within a short time. For example, in the "magical number rule 7 ± 2 " often mentioned in the interactive design, error will begin to occur after we memorize 5–9 groups of information. After short-term memory is memorized repeatedly, it will become long-term memory and can be saved permanently.

The memory disorders of the elderly are mainly reflected in short-term memory, retaining of memory and the difficulty to learn new knowledge. Short-term memory will decline with the growth of age, which is not because we cannot pay affective attention to relevant information, but because we cannot effectively neglect the irrelevant information. As a result, the limited capacity of short-term memory system will be overloaded.

After the age of 50, our memory performance will begin to grow weaker and our memory of numbers and memory that do not rely on language will begin to decline. It takes longer time to remember a thing, and the ability to save new memories is poorer than youngsters.

However, the elderly can well remember past things related with their life, or the long-term memory practiced logically. For example, our grandpas and grandmas often tell us the stories that happened when they were young.

Kansei image term: Repeated recital, dictation and use can generate images in our brain.

Thinking

Thinking is a process of analysis, comparison, summary, conclusion and abstraction based on the information acquired by us from senses and perception to form concepts, inferences and judgments, which is the highest form of cognitive activities of the humankind.

The knowledge of the elderly may increase with age. However the agility, smoothness, flexibility, uniqueness and creativity of their thinking will become poorer than that of young age.

Kansei image term: Our perception and memory will decline with the growth of age along with the loss of concept, logical inference and solving ability.

In the era of Internet fragmentation, all of us find it difficult to focus our attention. That is because various stimuli come in succession, we have to divert our attention. However, for physiological reasons, the elderly’s attention becomes blunt and cannot last long, without the accuracy and speed required for the control of attention in their youth.

By the above analysis of the Kansei image of the elderly and analysis of factors, the main factors that determine the images of interactive design are found so as to provide the designers with a direction for interactive design in the future. Regression analysis is used to explore the association between somatic feel and perceptual elements and Kansei evaluation and their mutual influence is concluded. The research method of KES (Kansei Engineering System) is shown as below Fig. 3. Designers begin to pay attention to the subtle physiology, psychology and emotions of the elderly. Products that analyze Kansei factors and can reflect the ideas of users will surely emerge. The thought will be established in which the development of new technologies is based on the physiological and psychological factors of the humankind. Therefore, we are convinced that in the 21st century, more attention will be paid to the elderly.

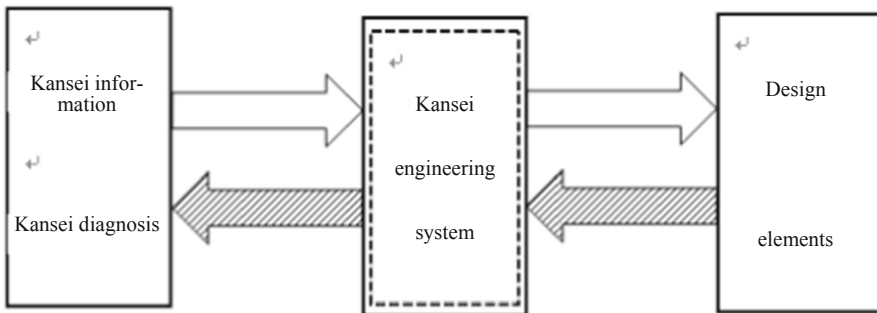


Fig. 3. Schematic diagram of mixed Kansei engineering

4 Conclusion

Through the above analysis and research, the forward Kansei engineering system and reference to Kansei physical data can effectively support the product development of designers when designers consider “producing Kansei products”, as shown in Fig. 3.

The macroscopic factors of products include basic background information of target groups for designing such as financial situation, consuming power, behavioral habits, brand awareness of products, development trend of the market, basic development direction. The macroscopic Kansei semantics of products will be analyzed with forward Kansei engineering.

Focusing on the research of the elderly and their consciousness, individuality, aesthetics, diversity, happiness and comfort, the aforementioned forward and backward Kansei engineering systems are integrated into a mixed system that can convert in two ways. According to the research of elderly products, more attention should be paid to the Kansei understanding of products while pursuing product quality. We should create life for the elderly based on Kansei design and create a system to convert Kansei into specific design elements, thereby enhancing the experience of products.

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