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Industrial Design

Redesigning a kansei engineering designed scissors by user centered design approach

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Abstract

This paper is based on the research which was conducted earlier on Kansei Engineering (KE) and resulted in a new concept for scissors to redesign it with another method called "User Centered Design" (UCD). This is a shift from translation of the consumers' psychological feeling about a product related to their perception of the design (KE) to focus on designing for and involving users in the design process (UCD). According to UCD process, after understanding and specifying the context of use, specifying the requirements and evaluation of KE concept were simultaneously (By 52 users, 30 female and 22 male), next steps were producing design solutions and evaluating those solutions about requirements (By 41 subjects, 26 female and 15 male). Specifying the requirements and evaluations were by usability test via focus groups and interviews. The final concept obtained high available satisfaction rates defined in the research project. In addition, some comfort design factors for hand tools (e.g. reducing wrist bent while working and reduction of hand pain) were measured and the new designed product achieved a highly satisfactory result. At last a comparison between UCD and KE had been done.

Keywords: *User centered design, Usability test, Scissors design, Kansei engineering.*

1. INTRODUCTION

Product design is a problem-solving activity, which aims to develop a successful product fitting consumers' needs. In today's market, product success is determined by customer satisfaction, so product design concept has shifted from manufacturer-oriented to customer-oriented. Most successful companies use some techniques to create products that appeal to customers. Prior 'producer centered' techniques focused on improving product functionality with respect to goals established by the producer. Thus, designers focused on users' psychological needs since having a lot of goods at home, consumers want to have goods more needed, attractive and very sensitive to their personality and compatible with their needs and feelings. The analysis of users' perception has been traditionally conducted using market research techniques in which users participate only as an evaluation source (and not as requirements generator), and products are evaluated and subsequently redesigned if deemed necessary. Hence, the feelings and the needs of the consumers are identified like crucial values for manufacturers [1-8].

Accordingly some methods have been adopted for designing products; some that notice users, their needs and their feelings, for example, emotional design, Kansei engineering, and user centered design, etc.

1.1. Kansei engineering (KE)

The Japanese word, Kansei has the significance of feeling, impression and/or emotion. Kansei engineering, as a kind of human ergonomic technology refers to the translation of the psychological consumers' feeling about a product related to perception in design. Kansei Engineering is a product development methodology, which translates impressions, feelings and demands of the customers on the product or an existing concept to design solutions and design parameters and converts feelings and impressions (Kansei) into product parameters and design specification [5, 8-11].

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1.1.1. KE background

This method had been employed to design a myriad of different kinds of products and has a wide area of applications, like automotive industry, electronic devices, home and work equipment, architecture, everyday things, etc. Here some of these projects are introduced. Several main Japanese companies in varied business areas used KE to improve their products. Mazda Company was employed this method and designed Mazda Miata. Sharp Co. designed video cameras with an adjustable external LCD display. Additionally, refrigerators, shampoos and hair cleaners, doorknobs, washing machines, ceramic souvenir and so many other products have used this method to design and improve themselves [6, 10,12-15].

2.1. User centered design

Industrial designers had designed many products, finally, after the product's production they faced some problems that users had in an interaction with their products, and sometimes designers were never aware of those problems and after manufacturing, they left everything about that product. While those problems could be solved so earlier, it seems that they need a method to identify and solve problems sooner. User centered design (UCD) as a general term for a philosophy and methods which focus on designing for and involving users in the design can play this role for designers. Also, UCD is a product development approach that is concerned with the end users of a product and the philosophy is that the product should suit the user, rather than making the user suits the product. The UCD model described by Buurman advocates a design process that involves users in the whole design process in order to match the product to the user requirements and to increase its practical use. This can be assessed early in the lifecycle via usability testing of prototypes [16-19].

In a usability test, users are given a prototype or the final product and asked to complete a series of typical tasks using the product. This activity enables you to identify the usability issues with your product. Changes are subsequently made to improve the product before its release. Usability testing focuses on the user needs, the user empirical measurement, and iterative design. The final principle recommends that requirements be collected and the product be designed, modified, and tested repeatedly. The iteration of the design and the evaluation has been identified as a key to achieve effective systems and the way to avoid the ''user-centered design paradox'': ''We cannot discover how users can best work with systems until the systems are built, yet we should build systems based on knowledge of users and how they work.'' ''The solution [to the user-centered paradox] has been to design iteratively, conducting usability studies of prototypes and revising the system, over time''. The goal of these iterative evaluations is to verify if the interaction, as expected, identifies where the problems are, and what is wrong and how it may be addressed: They are an essential element in the system design as they keep the focus on the user [16-17,20].

1.2.1. UCD background

In the previous decades, people designed some things to satisfy their needs. Those things did not exist before and were created by the people. Furthermore, the design does not only mean the creation of new products in the form of drawing. Design involves everything, such as new products, processes, software, systems, organizations, methods, even novels and dramas.

Chen in, claims that the design process consists of two distinct processes: The creative process, where new ideas or solutions are synthesized in the absence of prior examples; and the analytical process, where design decisions are made by evaluating the new ideas proposed. The creative process depends strongly on the designer's knowledge base and creativity. He added that modern products under design have to satisfy consumers from various different perspectives in order to survive in the competitive market environment [21].

However, in recent years the way in which products are designed, developed and produced has changed. Technology is moving rapidly and the market is more competitive, giving customers more choice. Manufacturers are increasingly required to produce customizable mass-produced products to comply with the customer requirements. Brand, image and style have become important in product selection; technology is no longer the sole driving force in the development of a product. As the market is becoming more saturated, consumers are able to choose products in terms of what they like, and what expresses their own individual style and status. The new challenge for designers and manufacturers is being able to understand what customers like and what will help to build more pleasurable products [22].

The term 'user-centered design' originated in Donald Norman's research laboratory at the University of California San Diego (UCSD) in the 1980s and became widely used after the publication of a co-authored book entitled: User-Centered System Design: New Perspectives on Human-Computer Interaction Therefore the usage of user centered design method started. UCD has primarily been used for designing virtual systems and interaction design, although sometimes its usages in product design can be noticed [16, 20, 23-33].

Lai et al. adopted this method to select the suitable color combination for cell phones. Also Ma et al. involved users in the selection of suitable color combination for sofa and introduced the new method for these kinds of selection. Patel et al. UCD method used to design a remote control for the virtual environment. In 2008 this method was used to design a digital camera by Locher, Frens, and Overbeeke. Wu, Ma, and Chang applied UCD to design a hair washing assistive devise for users with shoulder mobility restriction. Kongprasert et al. The same year adopted this method to design a hand bag for women. Also, Frederking et al. used that for designing an intelligent system for children [34-39].

3.1. Scissors Design

Previously main authors had examined KE and designed a scissors via this method [40]; they used 10 types of existing scissors, identifying a paper cutting form and then testing 36 participants who had to use each pair of scissors to cut the form and answer about their feelings with 32 Kansei words which were identified before. Subsequent to analysing the data obtained from the test, the outcome of this study was designing a new concept for scissors which is demonstrated in Fig. 1(a).

The case study selected for this process was scissors since this was a continuous process and the product should have some properties to render it useful for such a study; the main reasons for choosing scissors are as follows:

(1). It must been designed and produced before and concepts were not suitable for this study,
(2). It should have many different produced models that exist in the market,
(3). It should be simple, not to waste our time and budget,
(4). It must have a special function and mechanism to help us not to design just the form and body of the product and have more flexibility in creating ideas,
(5). It should be in touch,
(6). It should be known for all users,
(7). The users of this product should be in touch and have no special properties since this can complicate the way we aimed to undertake the study.

Scissors had been designed a multitude of times but almost none of them were based on a scientific method for their works, except the study L. Boyles et al. conducted in 2003 evaluating the new designed ergonomic scissors by their users and making a comparison between that and the standard scissors in the market. They call their scissors ETD (Ergonomic Tool Design). This scissors and its' uses, and the comparison between ETD and the Standard Scissors in the market called STD are shown in Fig. 1(b,c).

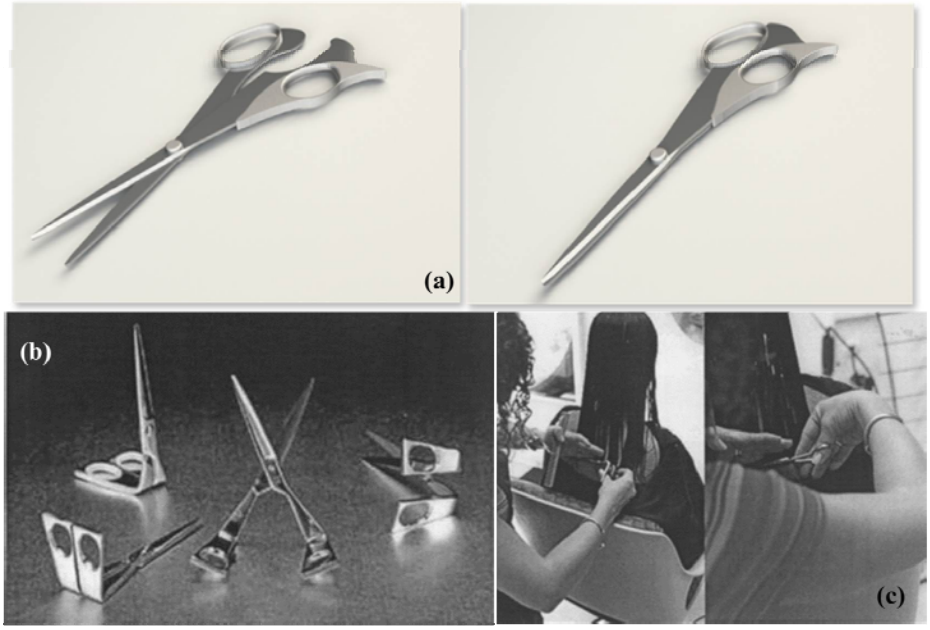

Fig. 1 (a) Scissors concept resulted from the previous study [40], (b) ETD scissors. Note that the fingers are parallel to the scissors blades instead of perpendicular [41], (c) ETD SCISSORS (Left) versus standard (Right) view 3. Note: The wrist in the right frame (Standard scissors) is bent at a 90 angle while in the left frame (ETD scissors) the wrist is in the neutral position [41]

4.1. Purpose

We aim to evaluate and redesign the KE designed scissors with the aspect of User Centered Design. So the research started with the evaluation of the KE concept and identifying context of use, then continued with gathering user requirements and iterative design and evaluation (through interviews and focus groups) to get the final concept.

2. MATERIALS AND METHODS

1.2. UCD process

User requirements refer to the features/attributes your product should have or how it should perform from the users' perspective. User-centered-design is a discipline for collecting and analysing these requirements [17]. Maguire [42] mentioned a cycle for UCD process (from ISO 13407) which is displayed in Fig. 2(a). According to him, this process, after specifying the plan, starts with understanding the context of use, specifying the user requirements and making design solutions. Then, it continued by evaluating those solutions involving the main users and stakeholders. Ultimately, the solutions will go through the cycle for a number of times until the satisfactory results are obtained from the users' evaluation.

This approach was adopted in the study with a few changes. Instead of creating a new design, another design solution from a different study with an emphasis on KE was used. Thus, after specifying the context of use, in

addition to specifying the user requirements, evaluation of the last concept was performed as shown in Fig. 2(b). Based on the suggested process by Maguire, Table 1 demonstrates the methods applied for each part of the process [40,42].

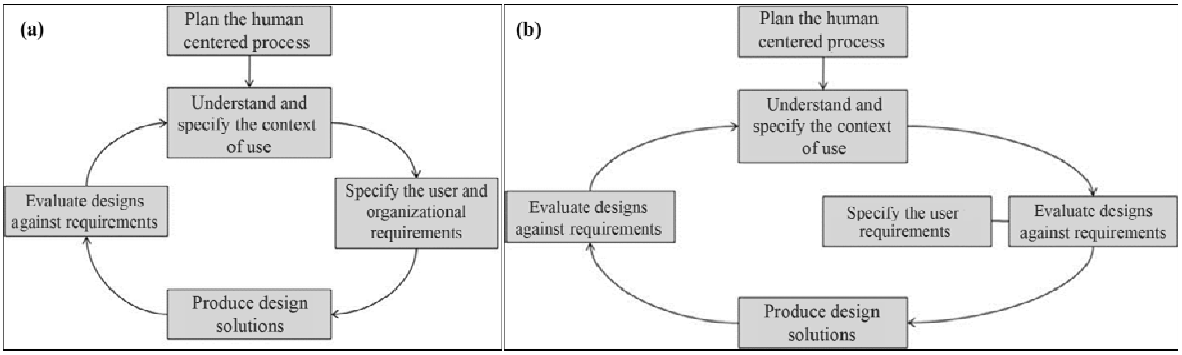

Fig. 2 (a) The human centered design cycle [42], (b) HCD cycle used in this study

Table 1 Scissors design process

Procedures	Categories of evaluation
Understand and specify the context of use	User analysis Task analysis Environment analysis
Specify user and organizational requirements	User requirements Interview Focus group
Produce concept designs and prototypes	Brainstorming Paper prototyping Software prototyping
User based assessment	Participatory evaluation

1.1.2. Context of use identification

The process to identify target users, tasks, technical, physical and organizational environment [42] was conducted using participant users.

52 users volunteered to participate in the current study (30 female and 22 male) which aged more than 10 years old because of the anthropometric data for hands in children as the start point of age range and grip strength in elderly people as the end point of this range. 10 year old children along with females (percentile 5) both have similar hand dimension (hand breadth is 64 mm for 5th percentage of females and 68 mm for 10 years old children, and hand length is 152 mm for 5th percentage of females and 150 mm for 10 years old children) [43], so the minimum age of users in target group was identified as 10. The maximum age of target group users was specified by grip strength as Bohannon et al. [44] mentioned. He claims that this will reduce by adding age. But people have different habits in old age. Most of the time, they do their own work by themselves as they can. Nobody can exactly specify that age. Therefore, the maximum age would be the time they are able to do their work by themselves. The target group age ranges are shown in Table 2. Participants were selected from the different age, job, sexuality and profession to reach more rigorous result.

To realistically design the task, the purpose of using scissors was determined as any job normally expected from scissors. However, generally speaking what they do with their scissors (e.g. opening screws, etc.) might be defined on a wide base but limited to those works which are done by most users and those with general use (e.g. cutting papers, cardboards, fabrics, hair, nail, tapes, metals with low thickness, etc.).

Table 2 The age range (YRS) of target users participated in the first part of this study

	10-15	16-20	21-30	31-40	>40	Total
Frequency	5	2	29	6	10	52
Percent	9.6	3.8	55.8	11.5	19.2	100

Field study and observation were conducted on participants to find out if they use and keep their scissors in different ways not known to the authors (designer). This resulted in identifying homes and closed spaces.

2.1.2. User requirements

User requirements were distinguished by applying focus groups and interviews. The focus group method has been explained as eight to ten end users who are brought together for an hour or two to provide information in response to a series of questions, or to provide their subjective response to product demonstrations or concepts [17]. However, in this study identifying the actual requirements was performed by applying the evaluation suggested in Kansei Engineering for scissors concept prototype. Problems which users experienced with the usability test revealed some requirements which are not yet met or must be different in that concept.

More of information was collected by users talking to each other. First the general purpose was identified for all of users and then asked them to use prototypes or take a look at them and try to speak about their experiences which they had with the product at all. So researchers didn't ask participants and subjects some exact questions, and more tried to lead them to speak better and more about what they know and had experienced.

3.1.2. Iterative design

By finding the problems users had with the existing concept, changes were applied to the new design depicted in Fig. 3 (concept 1). The prototype was later made. The new prototype was evaluated by users, which resulted in three new ideas through brainstorming and user interviews. Ideas were modelled in the 3D software and a new evaluation was made by them Fig. 3 (concepts 2- 4). Ultimately, all assessments were incorporated in a totally new concept that used a clever design and the highly ergonomic considerations are shown in Fig. 4.

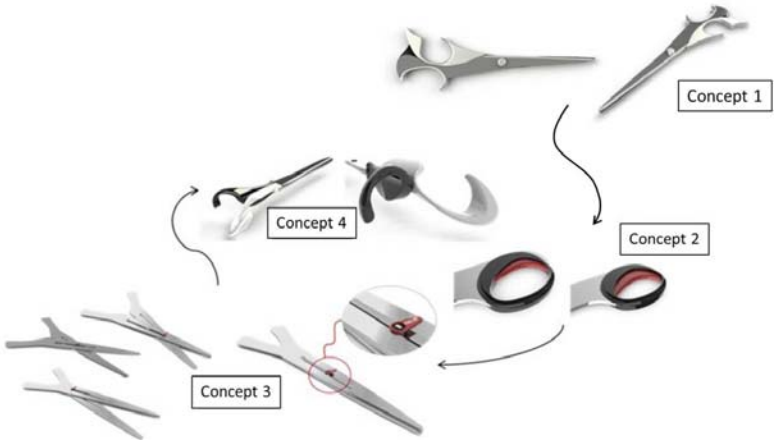

Fig. 3 New concept which resulted from the evaluation of Kansei engineering concept (concept-1) and Concepts which resulted from user requirements and evaluation of concept-1

Fig. 4 Final concept

4.1.2. User evaluation

User evaluation was performed in two different sections. One of them was through interviews and participatory evaluation that the subjects evaluated the new design. After each modelling phase (in real prototype or 3D software) concepts were evaluated by users, divided between females and males. The final concept was also evaluated in the same way as other concepts, with better satisfactory results at the end. First model which was the result of KE was modelled as functional prototype, other concepts were just modelled in 3D software and the final concept was modelled as prototype which subjects could touch and use it, but this scissors prototype couldn't cut anything and didn't work like the real product. As mentioned previously, the evaluation was through interviews and focus groups.

Nonetheless, in the second section, other 41 volunteer participants (15 male & 26 female) evaluated the newly designed scissors, called UCD scissors, and identified the pain points on their hands after using the UCD scissors. None of these participants had any specification in using

scissors and as before all were over 10 years old. This number of individuals (41 subjects) was selected because of the number of subjects participating in another research and evaluation which L. Boyles et al. had conducted in 2003. We sought to evaluate UCD scissors with the result of that research. Also they were volunteers as a kind of random selection, to ensure their neutrality towards the product. We wanted they have not any idea about the product which they encounter.

3. RESULTS AND DISCUSSION

This phase is concerned with what was obtained in aforementioned steps.

1.3. Iterative evaluation

As mentioned in section 2.1.4 each concept was evaluated by users through participatory users' evaluation using both genders. Table 3 shows the result of participants' evaluations about each concept, for each gender and each age range separately. The table demonstrates that concept 1 received high disagreement from evaluators. The main reasons for such disagreement were insecurity and non-functional usability. Concept 2 had variable handle size which helped users with a better grip. Scissors with changeable handle size would better fit and users can activate this function by clicking at the bottom of the handle. The results revealed that users were more satisfied with this usability. However, users had some comments in terms of the design of the concept with smaller scissors ring size. The aesthetics and few functionality considerations were added to this list as well.

Table 3 Participants' evaluations about each concept, for each gender and each age range separately (numbers are the frequency of participants)

Concepts		Female (age range)						Male (age range)						Total percentage
		10-15	16-20	21-30	31-40	>40	Total	10-15	16-20	21-30	31-40	>40	Total	
Concept 1	Agree	-	-	1	1	1	3	-	-	1	-	-	1	11.4
	Disagree	2	-	16	1	2	21	1	-	4	3	2	10	88.6
Concept 2	Agree	2	-	14	1	3	20	-	-	7	2	2	11	73.8
	Disagree	-	-	3	1	1	5	-	-	4	1	1	6	26.2
Concept 3	Agree	2	-	16	3	3	24	1	1	9	2	2	15	84.8
	Disagree	-	-	1	-	2	3	-	-	2	1	1	4	15.2
Concept 4	Agree	3	2	16	3	4	28	1	1	7	1	3	13	83.6
	Disagree	-	-	1	-	1	2	-	-	5	1	-	6	16.4

The third design (concept 3) which had an adjustable hinge for cutting materials with different rigidities was also evaluated by the users. Results show that the users were satisfied with this concept; however, their comments revolved around the element on the blades which could become larger to make it more usable. Moreover, they believed the concept would have a wide range of usages as they might need. They were pleased that the adjusting hinge was easy to use.

The last concept, concept 4, showed different handle forms far from what the standard scissors have, so the grip would change for new scissors. Users believed that the concept was more aesthetically pleasing and innovative but some had different views. They addressed the grip and security issues.

2.3. Final concept evaluation

The majority of participants were pleased with the final concept which was the mix of concepts 3 and 4. Table 4 displays the results of evaluation.

Table 4 Participants' evaluations about the final concept, for each gender and each age range separately (numbers are the frequency of participants)

Concepts		Female (age range)						Male (age range)						Total percentage
		10-15	16-20	21-30	31-40	>40	Total	10-15	16-20	21-30	31-40	>40	Total	
Final concept	Agree	3	2	8	3	4	20	2	-	5	1	3	11	86.1
	Disagree	-	-	-	-	-	0	-	-	2	1	2	5	13.9

Furthermore, the prototype of the final concept was made and presented to some of the users (41 participants, not just those who participated in previous sections) to find if they feel any pain in any parts of their hands while using. Participants must keep the scissors' prototype in their hands and try to use it like when they use the real product and say if they feel pain or stress in any parts of their hands (specified parts were based on those which L. Boyles et al. were identified). Based on studies by L. Boyles et al. in [41] who compared their ETD scissors with the standard scissors, a new comparison was made among three concept scissors (STD, ETD and UCD)

shown in Fig. 5. The comparison revealed that there was a reduction in pain regions from ETD to UCD scissors and the number of individuals who felt pain in those regions also reduced in the UCD scissors compared to others.

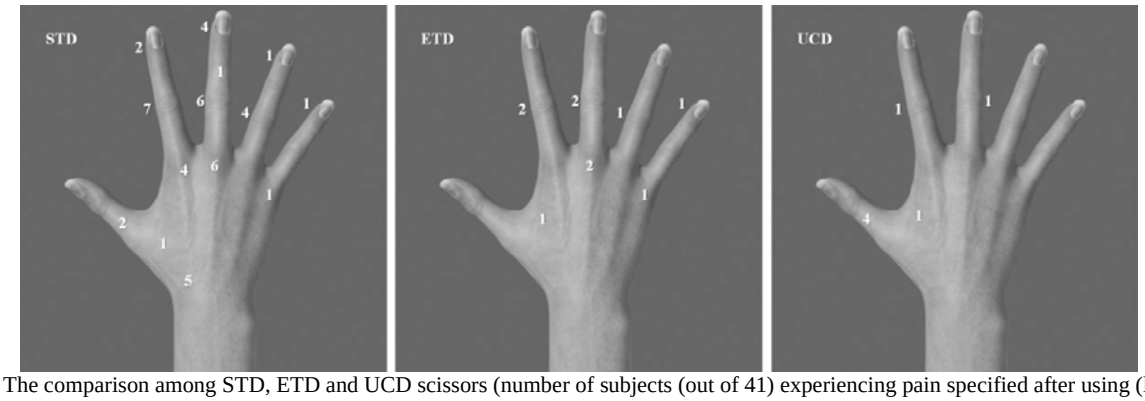

Fig. 5 The comparison among STD, ETD and UCD scissors (number of subjects (out of 41) experiencing pain specified after using (left) the standard scissors (STD), (middle) the ergonomic scissors (ETD) [41] and (right) the final concept of this research (UCD))

In recent years, the emphasis is placed on the role of the user to do the job harmlessly, effortlessly and comfortably. Also, several objective measures use to evaluate hand tools, like muscle activity (electromyography-EMG), grip force distribution and grip force, and hand-wrist postures. A common RMI (repetitive Motion Injuries) symptom reported today is carpal tunnel syndrome (CTS). CTS also has been labelled occupational overuse syndrome or repetitive strain. CTS is caused by compression of the median nerve, which passes through the carpal tunnel in the wrists . One of the ways to reduce these injuries is to decrease the time of wrists bend for repetitive works[41, 45,46].

Another comparison between UCD scissors and Kansei engineering scissors (which was for the previous research) showed that UCD scissors would result in less wrist bending than Kansei scissors Fig. 6. This reduction in bending the wrist while using scissors may cause the reduction of repetitive strain injuries and carpal tunnel syndrome for those with repetitive works.

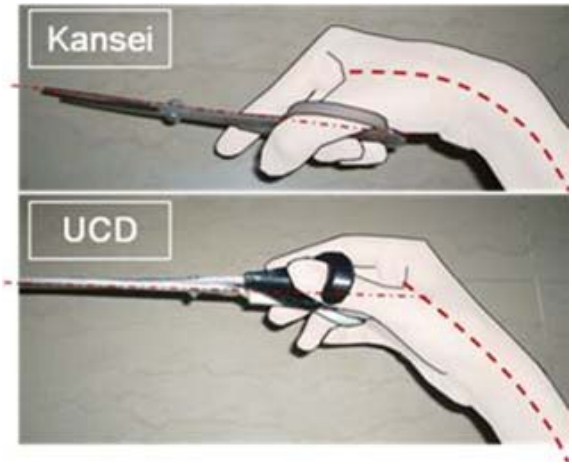

Fig. 6 The comparison between wrist bent in concept of the previous Kansei study [40] and the new UCD concept

4. CONCLUSION

1.4. Main study conclusion

A research study was undertaken to design scissors by applying the principles of user-centered design. This would yield good results for users and their needs. Users have experiences different to others and they may do some works that other people may never do. Approaching the users in this research study had unpredictable outcomes.

One of the unexpected results was about younger users in comparison to the elderly people. While youngsters tend to use one pair of scissors for all jobs, elderly people and those with experience and responsibilities prefer to use different pairs of scissors for different jobs. It seems that the difference is because younger people want their work done, regardless of its quality. They only want to reach their goal in the easiest way. In the meantime, those with experience consider the job important and precise.

The other result achieved in this research was that users believed in cutting metals (like aluminium, narrow steels, copper, and brass sheets and steel wire) would make their scissors blunt. Nonetheless from the experience point of view, presented by some users it was found that not only metal cutting does not make scissors blunt but also it would make them sharper than before.

Users' evaluation for concept 4 which was the base for the final concept revealed a meaningful difference between what males and females thought. This could be due to the difference between males and females in facing new things. It seems that females are more receptive and comfortable with changes while male users tend to use traditional objects.

According to what Sauer, Seibel, and Ryttinger, in 2009 claimed, users employing a reduced fidelity prototype chose generally higher control settings than those using the real appliance. Moreover, Sauer and Sonderegger, in 2009 mentioned that users may have mental anticipation of what the real appliance might look like and employed this mental picture as a basis for their rating. Thus, with the fidelity of prototype used in this research (the blade of prototype was made of balsa wood and handles were from PP) we cannot find the real answer, and could not find if the ideas and designs are really what users thought about them. Also the fidelity of prototypes which were made here differs from the prototypes made by L. Boyles, Yearout, and Rys in (it seems that the prototype was applicable and like the real appliance) and maybe if their fidelities were the same, varied findings were obtained Fig. 5.

Therefore, it is suggested that for subsequent studies the result of the use of the original product be compared to the prototype. Also, the ergonomics of the new concept compare to the previous design by more accurate tests[41,47-48].

2.4. KE vs. UCD

Finally, to reach a better conclusion it seems that the comparison between KE method as this study's pre-method and UCD as current used method is needed. So first, the process of each method which resulted in these two scissors concepts Fig. 1(a) and Fig. 4. are presented in Table 5. As shown in the table, KE process based on common available products that had been designed and used before, and the UCD process not necessarily needs available products or concepts (although in this research there was a concept to be evaluated). In KE, designers or researchers one time only meet end users and collect their perceptions, but in the most parts of UCD users are present. However in this research continuation of KE to UCD helped designers and researchers to connect with end users more and more and maybe that high satisfactory could be the result of this connection.

Table 5 KE process vs. UCD process which used in this research

KE process (prior study)	UCD process
Collecting Kansei word	
Collecting available different products as specimens (scissors)	
Structuring Semantic differential (SD) scale for Kansei words	Understanding and specifying the context of use
Classifying item/category	Evaluating KE resulted product and specifying the user requirements
Identifying a standard form for evaluation (paper cutting form)	Iterative production of design solutions
Evaluation experiment	Iterative evaluation of designs against requirements
Statistical analysis	Evaluation of last concept (visual and functional)
Interpretation of the analyzed data	Evaluation of last concept about stress and pain spots
Matching data to item/categories	
Designing new product	

In KE, researcher use a semantic differential based form to achieve user's feelings but in UCD with some interviews, users use non-technical words to describe what they need or want [49]. So it seems that KE findings are more valid.

Moreover, it seems that UCD means that you must take the most attention and notice on users to achieve data and then can design; KE also does this. So, KE can be a kind of UCD but just with focus on perceptions and feelings when UCD focuses on needs and requirements; these requirements can be about functionality and other physical properties or about feelings.

In this research, it is not clear that if the same subjects participate at both studies the same results were achieved, but some noticeable results showed that some of the subjects which had cooperation in both parts (KE & UCD), had satisfaction at the end. However, they delighted after looking at the first picture of the KE concept and thought that the concept was really what they wanted after KE test. But after starting the UCD process and using the prototype, some new ideas and needs were appeared.

As a suggestion, it seems that these two methods can be combined and be used with each other at the starting point. Each of KE and UCD can cover deficiencies of the other and finally can get better result.

CONFLICT OF INTEREST

The authors declare that there are no conflicts of interest regarding the publication of this manuscript.

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