

An Emotional Design Method Based on Human Design Technology

Toshiki Yamaoka*

* *Wakayama University, Faculty of Systems Engineering
Japan, yamaoka@sys.wakayama-u.ac.jp*

Abstract: The purpose of this paper is to describe how to construct an emotional design method logically based on Human Design Technology (HDT). At first 9 emotional design items were extracted. The 9 emotional design items are: 1) Color, 2) Fit, 3) Shape, 4) Functionality and convenience, 5) Sense of material, 6) Design images, 7) Ambiance, 8) New combinations, and 9) Unexpected application. These 9 items were classified into three layers using ISM. HDT is a kind of system development method. The method to construct emotional design based on HDT is described as a procedure of HDT. (1) User requirements of emotional design are collected by questionnaire. (2) Competitive products from viewpoint of emotional design can be compared using formal concept analysis. (3) Formulate structured design (product) concepts. (4) The design is visualized based on the structured concept. (5) The emotional design plan is evaluated by AHP from viewpoint of validation and verbal protocol. According to the above-mentioned procedure, an alarm clock was designed as an example.

Key words: *emotional design, Human Design Technology, structured concept*

1. Introduction

As people of most of countries enjoy a high standard of living in 21 century, an emotional design has become very important in product development. The purpose of this paper is to describe how to construct an emotional design method logically based on Human Design technology (HDT). Usually an emotional design was done by designer's intuition. However, in case of systematic and complicated emotional design with other design factors (ex, ergonomics) like chairs and so on, it is very difficult for designers to design those products by only designer's intuition. As products are designed at a high level of emotional design constantly, the emotional design should be designed by logical or systematic design method for constructing charming products. The logical and systematic design method makes designers be able to construct the good emotional design constantly whether they have their ability to do the emotional design or not.

The logical and systematic design method in this paper is HDT. Namely the emotional design can be constructed using emotional design items based on HDT.

According to Kansei Engineering [1], users using Kansei Engineering mainly are not designers and the data needed for Kansei Engineering are searched each time. Meanwhile, the users using an emotional design method are designers and they can do the emotional design using the nine emotional design items based on HDT.

2. Elicited emotional design items

2.1 Method to search emotional design items

18 engineers (one female and 17 men, early twenties) were asked to choose objects like product, food and so on which they feel to be emotional in their daily life. They collected objects freely and wrote the reasons to feel emotionally.

2.2 Results

The collected objects and their reasons were changed into emotional design items. These items were classified into 9 groups using KJ method (Figure 1).

The nine emotional design items are as follows.

- 1) Color: Color elements like peaceful colors and unconventional colors.
- 2) Fit: A sense of human and machine integration such as comfortable shape or an enveloping sense.
- 3) Shape: Elements like a simple shapes or smart shapes.
- 4) Functionality and convenience: Elements related to function and convenience such as good functions and usability.
- 5) Sense of material: Elements that have a sense of material such as the richness of a material, the novel use of a material.
- 6) Design images: Design image elements like contemporary, nostalgic and chic.

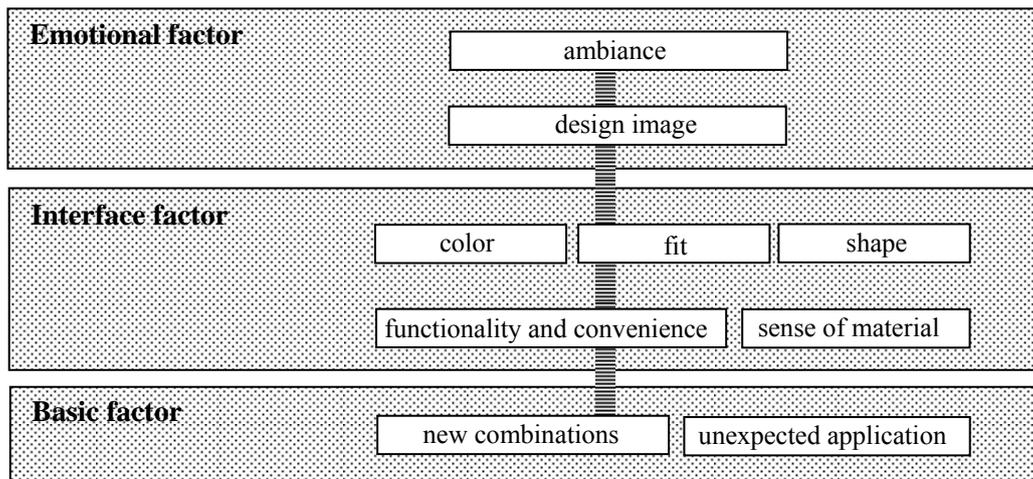


Figure1. Structure of the 9 emotional items

- 7) Ambiance: Elements like nice interior and relaxing atmosphere.
- 8) New combinations: The effect of completely new combinations such as image and audio combinations or harmonizing contradictory items (Figure 2).



Figure2. An example of new combination



Figure3. An example of unexpected application

- 9) Unexpected application: Although this is closely tied to new combinations, it is a basic item that evokes an emotional reaction (Figure 3).

These 9 items were classified into three layers using ISM (Interpretive Structured Modeling). ISM is a method which makes information structured based on graph theory. Upper layer consists of “a mbiance” and “design images” as emo tional factor for designing. Middle layer consists of “co lor”, “fit”, “shape”, “functionality and convenience” and “sense of material” as interface fac tor for designing. Lower la yer consists of “ne w combination” and “unexpected application” as basic factor for designing.

2.3 Discussion

We can recognize that the basic factor of “new combination” and “unexpected application” causes a product (system) to have emotional feeling. The interface factor makes the good relationship between human and machine which causes emotional feeling. The emotional factor of “ambiance” and “design images” makes users have emotional feeling. So the nine items mean nine emotional design items for constructing emotional design.

The three layer make users have emotional feeling in turn from the basic factor effectually. At first (step 1), a product is designed to embed with the basic factor. Next (step 2), the product is designed to make it better from the viewpoint of the relationship between human and machine. Finally (step 3), the product which is embedded with factors of the basic factor and the interface factor is designed to create “ambiance” and “design images”.

Figure 4 shows the relationship between human and product (system).

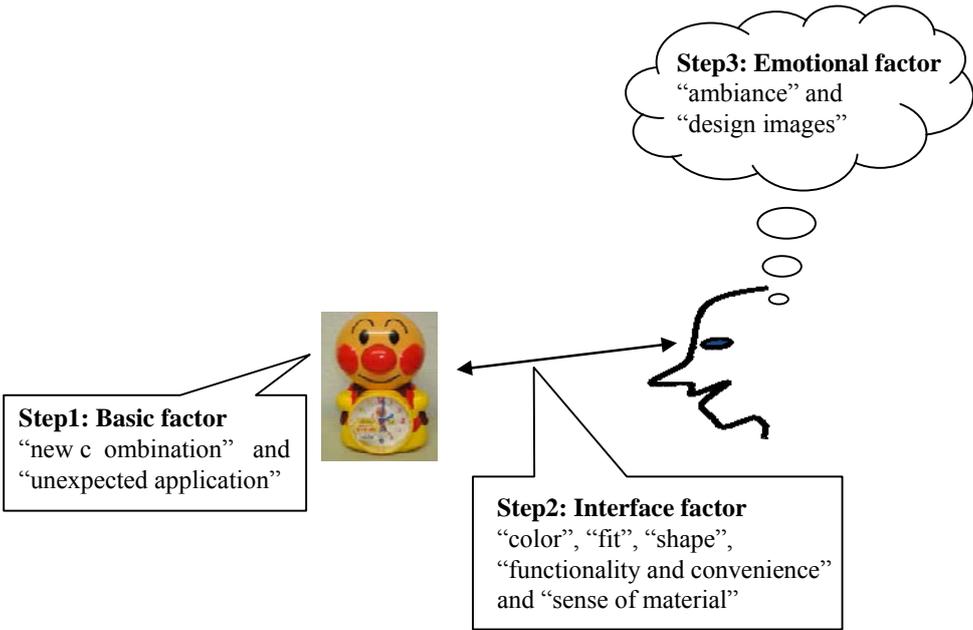


Figure 4 The relationship between human and product (system)

Emotional factor	Interface factor	Basic factor
<p>ambiance—nice interior, relaxing atmosphere, etc</p> <p>design image— modern , casual , chic, classic , nostalgic, etc</p>	<p>color— peaceful ,pale, colorful, etc</p> <p>fit— comfortable shape , an enveloping sense, etc</p> <p>shape—simple, smart, complicated</p> <p>functionality and convenience — good functions and usability.</p> <p>sense of material— the richness of a material, the novel use of a material.etc</p>	<p>new combinations— image and audio combinations, harmonizing contradictory items, etc</p> <p>unexpected application— unique, advanced, original, etc</p>

Figure 5. The emotional design items and its subordinate items

As users become to have emotional feeling based on the nine emotional design items, the three steps seem to be the cognitive process of the two factor theory of emotion of Schachter and Singer [2].

When designers can understand the structure of the nine emotional design items (Figure 5), they can collect suitable emotional design items quickly.

3. The outline of HDT

HDT (Human Design Technology) is a kind of system development method. It integrates fields like marketing research, ergonomics, cognitive science, industrial design, usability evaluation and statistics (multiple variable analysis) in order to design user friendly products. It is defined then as technology that scientifically analyzes human beings and uses various information related to humans (i.e. physiology, psychology, cognition and behavior) as design conditions [3]. The technology not only applies to all processes ranging from product planning to design and evaluation, but its logical, quantitative approach can also be applied all the way through the upstream end of goods production.

The following steps comprise the HDT process:

(1) Gathering user requirements;

Extracting problems and needs related to a product. This usually involves group interviews, direct observation, task analysis and evaluation grid method and so on.

(2) Grasping current circumstances;

Investigating how users perceive a target product in the market using correspondence analysis and cluster analysis.

(3) Formulating structured design (product) concepts;

Constructing structured concepts based on user requirements and other types of information.

(4) Designing (synthesizing);

Visualizing a product based on the structured concepts

(5) Evaluating the design;

The design plan is evaluated from viewpoint of Verification and Validation. Verification checks whether the design plan is designed based on the concept or not. Validation checks whether the design plan is designed for achieving the purpose of product using AHP (Analytic Hierarchy Process), SUS(System Usability Scale) and protocol analysis or not.

(6) Surveying usage conditions;

Investigating purchaser attitudes towards the resulting product to identify needs for future product development.

4. Construct emotional design based on HDT

4.1 Applying the nine emotional design items to the process of HDT

According to process of HDT, the special process of emotional design is as follows:

(1) Gathering user requirements;

User requirements of emotional design are collected by questionnaire. The results of questionnaire are analyzed by the quantification 1 and the Boolean algebra (Quine-MacClusky method).

(2) Grasping current circumstances;

Current circumstances of emotional design are grasped by questionnaire. The results of questionnaire are analyzed by correspondence analysis and cluster analysis.

(3) Formulating structured design (product) concepts (Figure 6);

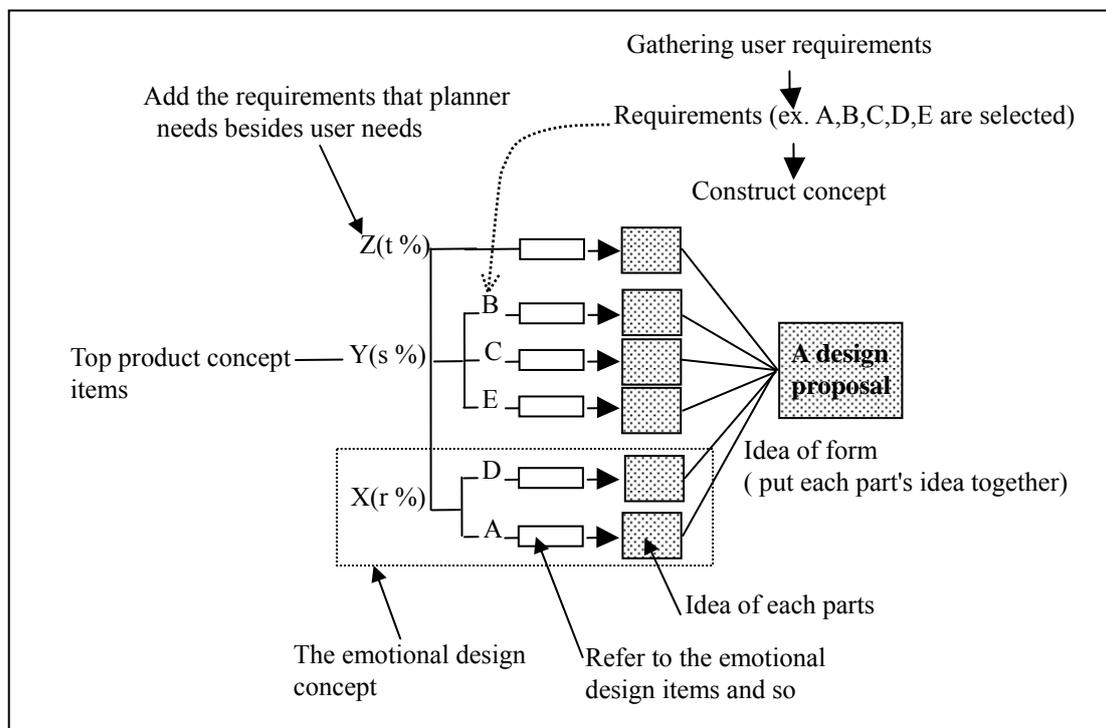


Figure 6. Structured concept
[Structured concept is constructed structurally based on requirements.]

Product design concept and also emotional design concept are structured.

(4) Designing (synthesizing);

Designers can visualized its image based on the emotional design concept and product design concept structured. These items of concepts are weighted.

(5) Evaluating the design;

The emotional design plan is evaluated by AHP from viewpoint of Validation and verbal protocol.

Focused on (2) grasping current circumstances and (3) formulating structured design (product) concepts, 4.2 and 4.3 show the method using examples of clock.

4.2 Compare competitive products from viewpoint of emotional design

In (2) grasping current circumstances, new design tendency to products is analyzed by formal concept analysis. The five clocks as an example were analyzed by formal concept analysis. At first, emotional design terms were selected. A person or persons evaluated the five clocks from viewpoint of the emotional design terms. The results are as follows. In this case, the author selected emotional design terms and evaluated.

Table1. Matrix of clocks and the evaluation terms

si	mple	colorful	adorable	Intellectual	ordinary
Clock-A	0 1 0			0 0	
Clock-B	1 0 0			0 1	
Clock-C	1 0 0			1 0	
Clock-D	1 0 0			0 1	
Clock-E	0 1 1			0 0	

Legend: 0 means “NO” and 1 means “YES

From figure7, three groups of emotional design of clock are understood. As the probability of each emotional term is calculated “not expressed in figure7”, the designers can select the suitable emotional terms for designing.

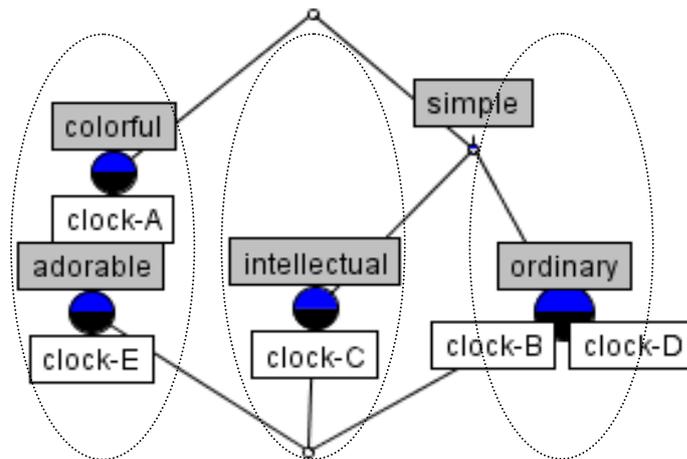


Figure7. Lattice line diagram of clocks and evaluation terms

4.3 Formulate structured design concept

(1) Construct structured concept:

It often happens that structured concepts are not clear enough, containing only a few lines of explanation. Since the main specifications must be determined at this stage, structured concept should be structured for logical continuity among their various items, thereby avoiding any omissions. The weighting of the different concept items is particularly important as a measure to ensure logical continuity among them. This is also significant for revealing the items that are important. Once the items are weighted, those that should take precedence may be determined automatically when certain design items must be traded off against one another. Weighting via questionnaires and the Analytic Hierarchy Process (AHP) is desirable so as to reflect user intentions. Since the weighted values also serve as a ratio for manufacturing costs, items of lower weighted value can be excluded when cost requirements aren't met.

(2) Constructing a Bottom-up structured concept (Structured Product Concept):

Problems and needs acquired in the user-needs-gathering step are then converted into user requirements, classified by function and placed in hierarchies. Should any new items of a superior rank become apparent, they can be added after studying the structural context of items of a superior concept and the overriding concept. Since the requirements originally arose from problems, any necessary and sufficient items of a product that are

omitted, or items whose addition may be desirable from a planner's point of view, can be added as the occasion demands.

(3) Constructing a Top-down structured concept:

Images of a product that the planner wishes to develop are selected to form a group of items for a superior concept. They are then broken down into their individual components, and those necessary for putting the concept into practice are selected to form a group of items of an inferior concept, thereby giving them structure.

(4) Draw up Specifications:

Since the outline of a system should have taken on a clear form by this structured concept constructing stage, specifications are drawn up to define them. Other things that need to be defined include the system's goals, responsibility sharing between users and the system, and the characteristics of the target users.

4.4 Design (Synthesis) Steps

The design is visualized based on the structured concept. HDT requires that the design is done based on the seventy predetermined design items including the emotional design items.

The seventy design items come under the following eight major design categories:

(1) User interface design (29 design items): A design for constructing user interface design in product

- 1) Flexibility, 2) Customization for different user levels, 3) User protection, 4) Accessibility,
- 5) Application to different cultures, 6) Provision of user enjoyment, 7) Provision of sense of accomplishment,
- 8) The user's leadership, 9) Reliability, 10) Clue, 11) Simplicity, 12) Ease of information retrieval,
- 13) At a glance interface, 14) Mapping, 15) Identification, 16) Consistency, 17) Mental model,
- 18) Presentation of various information, 19) Term/Message, 20) Minimization of users' memory load,
- 21) Minimization of physical load, 22) Sense of operation, 23) Efficiency of operation, 24) Emphasis,
- 25) Affordance, 26) Metaphor, 27) System Structure, 28) Feedback, 29) Help

(2) Universal design (9 design items): A design for constructing universal design in product

- 1) Adjustability, 2) Redundancy, 3) Understanding function and feature at a glance, 4) Feedback,
- 5) Error tolerance, 6) Acquisition of information, 7) Understanding and judgment of information, 8) Operation,
- 9) Continuity of information and operation

(3) Emotional (Kansei) design (9 design items): A design for constructing emotional design in product

- 1) Color, 2) Fit, 3) Shape, 4) Functionality and convenience, 5) Sense of material, 6) Design images, 7) Ambiance, 8) New combinations, 9) Unexpected application

(4) PL design (6 design items): A design for constructing safe design in product

- 1) elimination of risk, 2) fool proof, 3) tamper proof, 4) guard, 5) interlock, 6) warning label

(5) Ecological design (5 design items): A design for constructing ecological design in product

- 1) durability, 2) recycling, 3) very few materials, 4) most suitable materials, 5) flexible design

(6) Robust design (5 design items): A design for constructing robust design in product

- 1) strong material, 2) examining shape, 3) strong structure, 4) design reduced or avoided stress,
- 5) design for unconscious behavior

(7) Maintenance (2 design items): A design for constructing maintenance in product

- 1) keeping space, 2) easy operation

(8) Other (HMI design) (5 design items): A design for constructing HMI in product

1) physical aspect, 2) information aspect, 3) temporal aspect, 4) environmental aspect, 5) organizational aspect

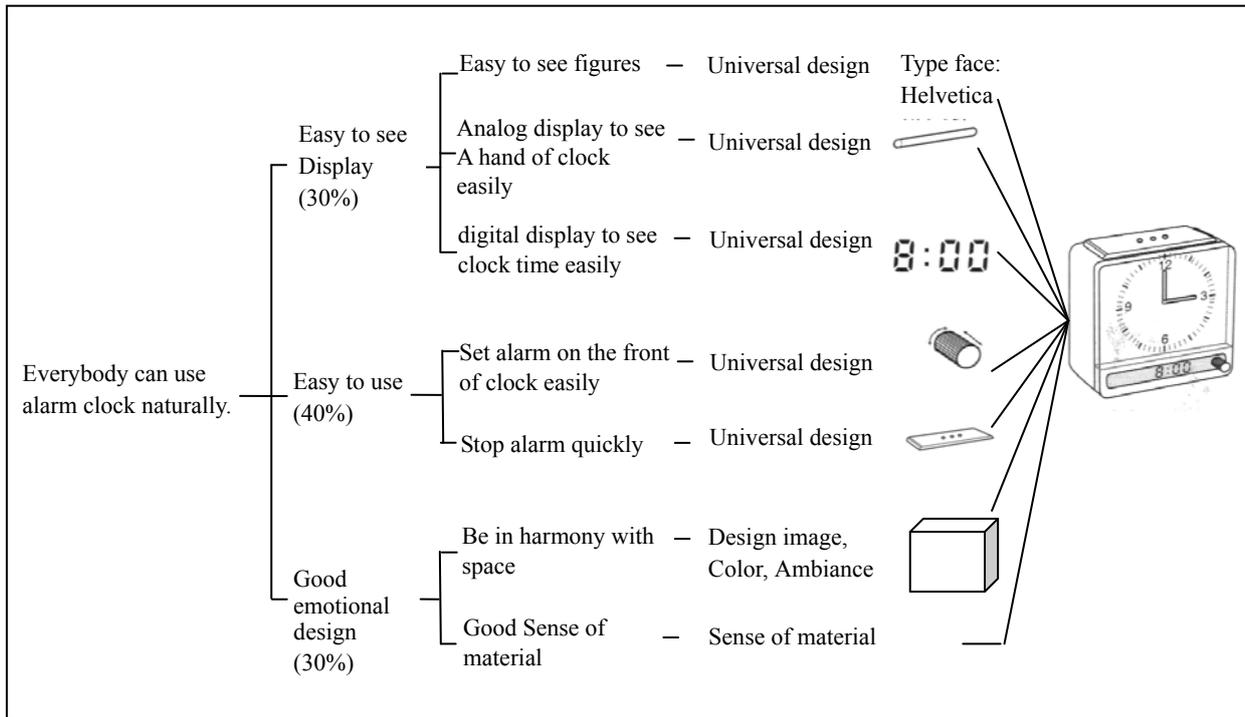


Figure 8. A structured concept of an alarm clock [4]

When designing a product, it is visualized (designed) with reference to the seventy design items including the emotional design items. By preparing a visualization plan for the parts corresponding to each inferior element of the structured concept and putting them together, a single design plan is accomplished. During this process, those parties involved in product development sit in front of their VDTs at a specified time to discuss common structured concept plans by presenting their visualization plans for each part, so as to formulate a final visualization plan. This process may be interpreted as CSCW (Computer Supported Cooperative Work). A structured concept of an alarm clock is as follows (Figure 8).

5. Discussions

The 9 emotional design items are extracted for constructing emotional design and also cause users emotional feeling. The nine emotional design items were classified into the three layer: the basic factor, interface factor and emotional factor.

The design process for emotional design was described based on HDT and the nine emotional design items.

The logical design approach is needed for constructing emotional design. As the usual traditional design method depends on designer's intuition or skill, it takes a lot of time to achieve emotional design. The reason is as follows.

(1) Designers designed using ambiguous concept which was not structured and not weighted.

Designers, engineer and planner and so on tried to talk each other in order to get clear-cut specification, as they had only ambiguous concept. This usual method caused them to need a lot of time to do emotional design.

(2) Designers don't know emotional design items systematically.

When they started emotional design, they tried to collect suitable emotional design items taking a lot of time.

When they know the structure of the emotional design items, they collect suitable emotional design items quickly.

Overall, it is clear that this method using the 9 emotional design items and structured concept is useful, effective and efficient for constructing emotional design.

6. References

[1] Nagamachi, M. (1989) Kansei Engineering, KAIBUNDO.

[2] Schachter, S., Singer, J. (1962) Cognitive, Social, and Physiological Determinants of Emotional State. *Psychological Review*, 69, pp. 379-399.

[3] Yamaoka, T. (2001) Human Design Technology as a New Product Design Method, First International Conference on Planning and Design, Taipei, CD JP003-F, pp.1.

[4] Yamaoka, T. (2007) Designing Based on Ergonomics, Design Protect, No.76, pp.25.

[5] Yamaoka, T. (2003) Human-Centered Design Using Human Design Technology - Applications to Universal Design and so on-, Plenary Speech, VXth Triennial Congress of the International Ergonomics Association, CD-ROM (00009.pdf, pp. 4).

[6] Yamaoka, T., Kubota, S., Nishimura, M. (2004) Designing an Adjustable Stool for Height Based on Human Design Technology, PROCEEDINGS of the HUMAN FACTORS AND ERGONOMICS SOCIETY 48th ANNUAL MEETING, pp. 980-984.