Industrial Designers' Attitudes Toward Product Design

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Abstract

The aim of this research is to find out the attitudes of designers regarding product design. Subjects practicing product design are the main targets of this study. Factors designers of different attitudes towards product design emphasize in project design are explored, from which types of industrial designers are speicfied in terms of their value point of view in product design. From related literautre, six design-oriented attributes were identified for the measurement of designer's attitudes towards product design, including affective aesthetics, form manipulations, behaviorial attitudes, production and functional requirements, objective conditions, and personal skills. In this study, Q-methodology was adopted to collect the information about how the industrial designers feel in processing their product design. Then, experts were invited to compile appropriate questions for the questionnaire. This questionnaire was divided into six types of design dimensions and contained 50 declarative sentences. The results of investigation were analyzed with Q factor analysis to study the interviewers' design attitudes. Six types of industrial designers in terms of their attitudes toward product design were identified. It is suggested that manager of the design department allocate suitable designers for the design team according to the features of design attitudes and the property and complexity of design projects.

Keywords: Designer's Attitude, Product Design, Q-methodology

1. INTRODUCTION

Industrial design refers to a kind of creative activity in which multiple disciplines such as engineering, human factors, commerce, aesthetics, social environment and culture are involved [1,2,3]. Due to the fact that industrial designers have an indepth understanding of the customer's preferences and needs, they play an important role in the procedure of new product development [4]. In the new product development (NPD), particularly from idea development to product innovation, industrial designers are primarily responsible for carrying out the specification of a new product and endowing a representative product form [5]. In the design process, designers are different in their ways of thinking and points of view [6], causing the outcome to be different.

The human resource is a key factor to enterprise competition ability [7]. The subtle allocation of the most appropriate personnel on the most suitable position at the most appropriate time in NPD will make possible the biggest beneficial result of the plan, equipment, and budget [8]. In the twenty first century, design has played a dominant role in NPD [9]. Therefore, managers at design department should be able to maintain the competition ability of the design divisions and

enterprises through the allocation of excellent man power so as to make biggest benefit for the company [10;11,12]. Employee selection is important in industries, jobs, organizations, and psychological research [13]. Psychologist Belbin generalized nine types of team members to help design managers select proper designers for an efficient design team [14]. In addition, personal characters are also used for the measurement of team member selection [15, 16, 17].

Industrial design is a job that integrates multiple lines of profession. In such creative activities, different designers may place more emphasis on some things and ignore other things due to their ways of thinking towards different parts of design. Their behaviors and attitudes may further influence their concept and value of products. Consequently, the authors attempted to explore the factors designers emphasize in product design from which types of value and attitudes designers have towards product design were specified. It is hoped to help design managers select designers most suitable for the team or duties for specific design projects. In a study similar to occupation classification, Wen and Mei explored the performance of NPD from the viewpoints of product managers in Taiwan IT industry and categorized product managers into six types, including project planner, technical director, marketing director, assembly director, manager in general, and project manager [18]. They also suggested the managing director to select appropriate product manager from the viewpoint of product innovation.

In this study, the survey is limited to the stages from idea development to prototype making in NPD and the designer's attitudes towards product design are brought forth for the explanation of the data obtained. It is similar to the individual design strategy of industrial designers proposed by Teng [6]. He claimed that designers would develop their own individual design strategies from the ways they work out ideas and solutions to varying problems. In his study, the approach and method designers used to solve problems are more emphasized. Particularly, it is focused upon the concepts and attitudes designers have in settling down design problems. For the classification designers' behavioral attitudes, Q methodology was used in the questionnaire survey and interview.

2. THE DESIGN ATTITUDES OF INDUSTRIAL DESIGNERS

The purpose of professional discipline of industrial designers is to cultivate personnel that are creative and capable of developing special styles of commodities for industries. Therefore, industrial designers should be able to apply their aesthetic disposition in product form, professional knowledge about specific industries and presentation skills in their duties. Moreover, they need to integrate knowledge from multi-discipline to work out products that fulfill the enterprise's expectation. In light of this, the authors attempted to explore industrial designer's attitudes, professional skills and duties in this study.

2.1 Attitudes

The term "attitude" is a specific evaluative response to things, objects and people. It is often stored in our long term memory. Some previous studies claimed that attitude is a mixture of permanent appraisal (positive or negative) people have toward persons, things, objects, and concepts, a sort of combination of positive and negative points of view [19; 20]. Kolter defined attitude as a lasting appraisal of liking or disliking emotional reactions, and activity tendency toward some concepts [21]. McGuire pointed out that attitude is a kind of assessment composed of three ingredients: affective, cognitive, and behavioral parts [22]. Ajzen & Fishbein proposed a theory of reasoned action suggesting that people's behavior could be only predicted from their special attitudes toward the things they concerned [23]. In other words, we cannot predict the target's real behavior only from the intention of their ideologies. Based on the abilities and skills industrial designers have learned and cultivated from the practical experience, the factors and key points industrial designers consider in the design and development procedure are originated from their subjective conscientiousness. And such kinds of inner awareness will by all means influence their tendency of attitudes toward product design and dominate the way they handle design projects in the manner of their outer behaviors.

2.2 Selecting Designers

In enterprises, the employee selection is often done under the person-job fit consideration, and the allocation of man power and organization is considered the most influential factor in the selection procedure [24, 25]. In addition to the evaluation of job characteristics, the multilayer allocation selection in enterprises also depends upon person-team fit and person-organisation fit [13]. In other words, in selecting designers, the design manager needs to take into consideration whether the person fits the job, whether the person fits the project, and whether the person fits the company's policy and value. According to Colbert, the practice of human resource strategy management in enterprises is based upon the employee's skill, behaviors, and interactions [26]. Therefore, design managers can evaluate designer's performance from his or her ability and potential [27]. Besides, Behling (1998) claimed that the best performance of an employee can be recognized by their personal characteristics in jobs [28]. Furthermore, Sonnenwald maintained that the selection of designers should be decided after the observation of the interaction between the designer and other team members [29]. In addition to the consideration of experience and ability for a certain role in the design team, a successful team also depends on whether the team members can develop the complementary relationships in the design activity [14].

2.3 Design-Oriented Attributes of Industrial Designers

During stages of product development, industrial designers need to take into account a variety of tasks, including the strategy making from conceptual design, marketing, product plan, and market positioning [30]. Hence, Cooper & Press suggest design schools pass on students what contains in design jobs through design knowledge, design techniques, and cases in design practice [31]. Among them, design knowledge consists of the appropriateness of materials, product form and manufacturing methods, workshop practice, human factors, design trends and methods, computer aided design, and practical design. In addition, design techniques cover developing solutions to the design problem, using creative methods in problem solving, problem analysis, data collection, problem evaluation and judgement, pursuing aesthetic acuteness and visual judgement, using sketches, drawings and computer aided design to develop and present ideas, making models and prototypes to solve problems, and communication in visual and verbal ways. At last, design cases include design history, design philosophy and contemporary issues, commercial consciousness, and marketing. In addition, Roozenburg & Elkels assert that in designing new products, designers should take into account product function, usage, appearance, quality, production, cost, market, and environment [32]. They also pinpoint that, for industrial designers, products are objects in psychological layer that possess cultural vales. To help designers set up design conditions, motivations, and grasp inspirations. Morrison & Twyford proposed key elements of design development, including issues of the organization of idea groups, techniques and materials, functions and costs, social culture and history, incubation of design ideas, design trends and fashion culture, social welfare, public opinions and development, and aesthetic ideals [33]. Moreover, Borja de Mozota claims that designers' jobs include problem resolution (plan and manufacturing), creation (produces beautiful things through industries), systemization (needs transformation), coordination (team work), and cultural contribution (semantic culture) [34]. In looking for jobs, industrial designers are primarily required to have the 3D model making ability, communication in English, 2D computer graphics, creativity, and imagination [2]. Hsu, Chang & Yang indicate the evaluation items for the junior designers, including product form, free-hand sketches, design creativity, personal characters, aesthetics disposition, product plan, manufacture engineering, computer application, ergonomic knowledge, and project schedule control. At last, as far as designer selection is concerned, the ranking order for designers are creativity, product form, design work quality, observation ability, and aesthetics disposition, from the viewpoints of design managers [12].

Design-oriented attributes	Detailed contents	Descriptions
Affective aesthetics	Design creativity	Creative thinking and problem solving ability.
	Aesthetics disposition	Sense and acuteness of arts, humanity, and fashion trends.
	Subjective affection	Emotional appeals that products pass on to the users.
Form manipulations	Product form	Ways designers use to make the product form, color, and texture.
	Ergonomic design	User interface and anthropologic requirements in product design.
Behavioral attitudes	Product plan	Key points and specifications according to the demands in the market.
	Activeness and responsibility	Keep optimistic, active, and curious and have sense of responsibility.
	Communication and coordination ability	Project presentation and interaction with colleagues in the jobs.
Production and functional requirements	Mechanical and structural design	Mechanic motions and structural design of the product.
	Operational function	User-centered product operations and functions.
	Material characteristics	Purposes and characteristics of varying materials.
	Machining knowledge	Knowledge for the application of machining tools in product manufacturing.
	Manufacture engineering	Knowledge in product manufacturing procedure.
	Engineering knowledge	Basic knowledge of mechanics, electronics, and so on.
Objective conditions	Marketing survey analysis	Distribution in the market, competitor's products, marketing channels, and the like information.
	Practical consideration	The ideas do not came out of nowhere but consider the practical production and cost.
	Marketing strategy	Methods in product sales.
	Project schedule control	The management and control of the procedure and timing in design projects.
	Interpersonal relationship	Getting along with colleagues in the design project.
Personal skills	Technical presentation	Presentation ability to show the familiarity designers have toward science and technology.
	Computer application	Ability in application of different compute r software.
	Free-hand sketches	Using free hand sketches for the idea development.
	Model making	Manual model making ability to verify the feasibility of ideas.

TABLE 1: Design-oriented attributes of industrial designers

From the above literature, design-oriented attributes of industrial designers were listed in Table 1. Among six design-oriented attributes, affective aesthetics include design creativity, aesthetics disposition of designers and subjective affections designers endow in products. Form manipulations refer to the unique methods designers provide in product form and the user interface. The behavioral attitudes are referred to the duty and attitude designers have in their jobs including product plan ability and communication and coordination ability. Production and functional requirements indicate that designers are able to handle mechanical and structural design in the implementation of design; they are familiar with the operational function, material characteristics, machining knowledge and manufacture engineering so that products will meet the requirements of good to use, durable, and easy to produce. The objective conditions refer to the

duties of different divisions or specific panels where designers are not in charge of or other businesses that do not directly influence the design activity. Some examples are the marketing survey analysis, marketing strategy and project schedule control that are not dominated by designers. As a final point, though practical consideration and interpersonal relationship are related to designer's job, they are not the major factors closely related. Personal skills are referred to as the representation of designer's professional competence in which computer application, free-hand sketches, and model making are basic skills and technical presentation indicates the familiarity designers have in the application of technical knowledge. For example, animation or the latest machining technique can reinforce product manufacturing conditions. The design-oriented attributes and their detailed contents are listed in Table 1.

2.4 Main Duties of Industrial Designers

Generally speaking, NPD may be divided into three categories, including functional division, project plan, and array organization [35]. Therefore, Teng proposed six types of design projects in enterprises based upon the types of missions in enterprises, including multiple sub-project teams, formal project team, informal project team, sub-contract double project teams, industrial design project team, and independent work [36]. There are advantages and disadvantages for team work and independent work. In terms of the productivity in five abilities in product form manipulation, independent designers are only better than a team work in the ability of major features. In other words, they are not as good as a design team in overview revision, feature alternation/assessment, mounting point, and particular details [37]. In addition, for the implemention of product ideas, independent working model and chain communication model are better than free-open team communication model [38]. According to the above-mentioned studies, project plan and array organization will be applied only in a large-scale NPD case. The duties of functional divisions contain the NPD tasks conducted only by the industrial design department and the frequent small-scale redesign and detail modifications.

From the viewpoint of product dimensions in NPD, there are three hierarchies: reasons for NPD, innovation properties in NPD, and types of NPD. Among them, reasons for NPD may contain market demands, new technique development, competition in couterpart products, product line expansion, and regular NPD. Innovation properties in NPD may consist of the addition of new functions, functional improvment, and differentiation in product appearance. Types of NPD cover totally new products, product expansion, current product redesign, product extension, and reposition of products [35]. From the viewpoints of design experts, design strategies cover product series, product diversification, product line expansion, deepened product lines, new target market, new technical innovation, cost down, sharing the same mould, adding additive value, creative product form, product image, product color, green design, and so on [6]. The idea development of industrial designers is mainly focused on product appearance, most of which are redesign, a few of which are totally new product form, and few of which belong to the functional structural design [39, 5]. From the above literature, the work of industrial designers are majorly design projects of independent work or a design team. In terms of the extent in product form redesign, industrial designers are often put in charge of product form redesign in serial products, new product form with old functions, totally new design, and new conceptual design.

3. Methods

In this study, 50 subjects engaged in industrial design were interviewed to explore the factors designers of different personal characters emphasize in design activities and projects. From this, types of value senses and attitudes regarding product design were induced. Q methodology was adopted to gather the viewpoints and cognition the subjects had toward product design.

From a pool of 56 industrial designers interviewed, 50 effective questionnaire surveys were collected. In these 50 subjects, 30 were male; 20 were female. In terms of the year range, 3 were in the range of 20-25; 23 in the range of 26-30; 16 in the range of 31-35; 3 in the range of 36-40; 5 in the range of 41-45. Overall, most subjects (46%) were aged between 26 and 30. In terms of the experience of design, 14 had 1 year of design experience; 25 had 1-3 years of design

experience; 7 had 4-8 years of design experience; 4 had more than 9 years of design experience. As far as educational degrees are concerned, 4 were with senior college degree; 12 with college degree; and 34 with graduate school or higher degree.

Sorting in Q Methodology

Q methodology is a method to explore or define the subject's attitude from their statements or opinions. In exploring personal attitudes, Q methodology makes it easy for a subject, even one that has difficulty in speaking out his or her mind subjectively, to express his or her attitudes from the statements [40].

In a special way similar to the psychological test, Q methodology combines the technique of factor analysis to offer a systematic and precise quantitative method for the assessment of people's subjectivity. Moreover, it helps to analyze and interpret the ambiguous and hard-to-explain personal views and opinions. The biggest advantage of Q methodology lies in the face-to-face interview in that the researcher can judge the effectiveness of data from the observation of the person interviewed. This helps release the doubt of the effectiveness of data in collecting the survey questionnaire, particularly by mail. Moreover, through the interview, the direct contact of the subject uplifts the authenticity of the research and, in the meanwhile, helps understand the opinions and attitudes of the group and individual subjects, from which some of them can be quantified for an objective analysis and definition of the target group's attributes [41].

In this study, a structured Q Sort was used to compile the content of statements. In the selection of the number of statements, 50 was the number for the formal experiment. In compiling the statements, the results and contents of related quantitative and qualitative studies were first referred to. Initially, 94 items of statements were made. To increase the reliability of the statements, twenty subjects were invited for the selection and improvement of the questionnaire of these statements before the expert validity test and the pilot test. From the degrees of importance of these questions, statements of which the correlations were low were deleted from cluster analysis. Then, the statements whose meanings were not clear were improved for a better readability. In this process, 94 statements were shrunk to 75. Feedbacks from the subjects were then used for the improvement of the contents of these 75 statements. Furthermore, to make it easy for the subject to understand the statements, five experts of 10-15 years in industrial design and design education were invited to delete or improve statements whose texts were not clear or doubtful to compile the formal questionnaire. In this process, the expert validity test was based upon two criteria: CVI (Content Validity Index) and ICC (Intraclass Correlation Coefficient). After the screening and revisions from these experts, 50 statements evenly distributed in six industrial design perspectives were determined.

In the design of questionnaire, Q sorting method was used in this study, in which each of 50 statements was printed on a separated card (5X8 cm^2). In the Q sorting test, the subject first divided these 50 questions into three groups with specific numbers. That is, 11 most important questions (grades 1-3), 28 moderately important questions (grades 4-6), and 11 least important questions (grades 7-9). Then specific scores were assigned to each card as shown in Table 2. In the test, the interview was conducted in an individual way so that the researcher could answer any questions of the subject immediately. After the test, the subject was asked to give his or her comments for the most important and least important statements for further references. Therefore, the subject worked much harder in filling the survey than the way they dealed with mail questionnaire survey. After deleting 6 subjects of lower reliability, a total reliability of 0.941 was found for the rest 50 subjects.

Degree of importance		Most important	←			Moderately important	→			Least important
Grades		1	2	3	4	5	6	7	8	9
Scores		9	8	7	6	5	4	3	2	1
Number of cards assigned	N=50	2	3	6	8	12	8	6	3	2

TABLE 2: The assignment and evaluation scores of Q sorting of cards

4. RESULTS AND DISCUSSIONS

This part discusses the result of Q Factor analysis, from which six types of designers in terms of their viewpoints of design direction are explained.

4.1 Importance Subjects Place on Design Attitudes

The result of Q Factor analysis indicated that there were 15 factors whose eigenvalues were bigger than 1, with 79.5% accumulated percentage of variance explained. If the rule that factors of which the eigenvalues are bigger than 1 is followed, then there would be too many factors and after the third factor, there would be only one or two subjects in a factor. According to Brown, there should be at least four to five subjects in Q factor analysis if a factor is to be defined [42]. Other scholars, for example, Lo claimed that there should be at least two or more variables that have remarkable factor loading in a factor [43]. Consequently, six factors were extracted in this study after the factors with only one subject were deleted. Totally, these six factors could explain 54.1% of variance (Table 3).

	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6
Eigenvalues	13.72	3.61	2.75	2.51	2.27	2.21
% of variance explained	27.44	7.22	5.51	5.02	4.53	4.42
Accumulated % of variance	27.4	34.7	40.2	45.2	49.7	54.1
Number of subjects (Male/ Female)	11 (8/3)	8 (4/4)	10 (6/4)	7 (5/2)	9 (5/4)	5 (2/3)
Percentage (%)	22%	16%	20%	14%	18%	10%

◎Extraction method: Principal Component Analysis, Oblique Rotation Method

TABLE 3 : Result of factor analysis of the design attitude statements

In Q factors, if the factor loading of subjects is higher, it is closer to the presumed attitude type. And if the factor loadings of some subjects in one factor are bigger than 0.80, they can be used as representative samples of the specific factor for further analysis (Lo, 1986). In this study, all the factor loadings of subjects in six factors were smaller than 0.8, a ranking order of the factor loading in six factors was therefore used to assign subjects to the factors they belong so as to explain the meaning or features of each factor. Because the factor scores of each subject varied in the statements, a standardization procedure of the factor score was conducted. Based upon the ranking order of factor scores of subjects (Table 2), a number from 1 to 9 was assigned as the standardized scores according to their positions in the ranking order. Table 4 lists the average factor score of each type of attitudes in six dimensions of personal characters of industrial designers. The standardized scores were then used for the analyses of design attitudes and tendency in personal characters.

	Affective aesthetics	Product form treatments	Attitudes in behaviors	Production and functional requirements	Basic requirements	Personal skills
Type A	5.60	5.56	4.63	4.56	4.38	5.17
Type B	5.40	4.33	5.13	6.00	5.88	3.83
Type C	4.60	4.67	5.50	5.33	5.75	4.00
Type D	5.70	5.78	5.25	4.11	4.25	4.67
Type E	4.70	5.11	4.00	6.33	5.88	3.50
Type F	6.00	5.11	4.25	4.89	5.88	3.17

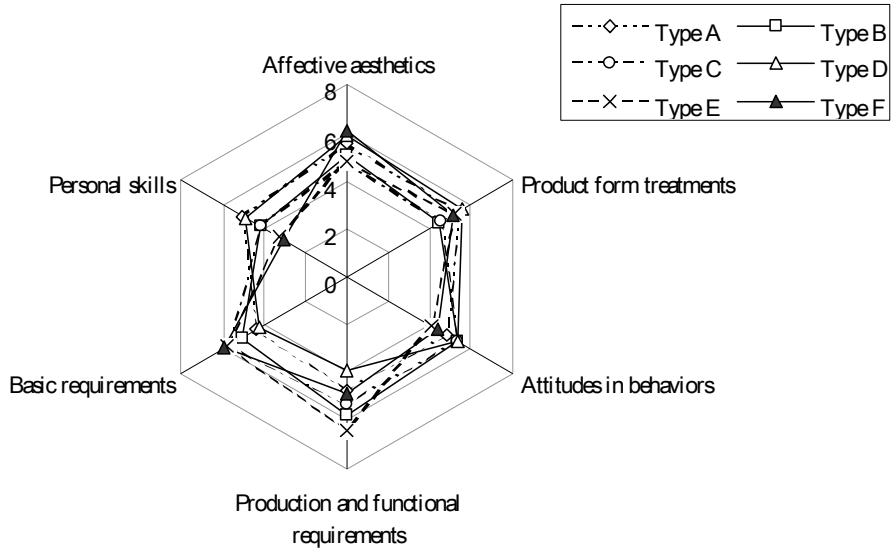

TABLE 4 : The average factor score of types of industrial designers and their distribution patterns in six personal character dimensions

4.1.1 Type A: Plan and Care All Aspects in Product Design

Eleven subjects belonged to Type A, the biggest group in six types, 22% in the total number of subjects. There were 8 males and 3 females, aged in the range of 26-35. In design experience, 7 were of 1-3 years and 3 of 4-8 years and 8 of them had the experience of multimedia design. The basic subject profile of this type indicated that Type A industrial designers can be referred to as young middle-aged generation with a certain period of design experience. Generally, they are not yet expert designers.

For Type A industrial designers, the most important statement was S05, Design is aimed to bring forth people nice experience in their life" whose factor score was high up to 7.409 (Appendix A)

In this group, five subjects chose this statement as the most important statement and two subjects considered S04, "A beautiful appearance is an important factor to consider in product design" the most important. These two statements belong to dimension of affective aesthetics. On the other hand, six subjects in this group considered S39, "Design should work out a compromising proposal that meet requirements of different parties" the least important, with a factor score of 1.809.Sven subjects in Type A regarded S27, "The amount of man power invested in a project depends on the amount of one's income" the least important, with a factor score of 2.146.This demonstrated that industrial designers in Type A were enthusiastic about product design. They believed that design should bring people fun and offer them better life experience.

Therefore, they would not cater to the market place with a compromising design due to the short amount of pay.

From the interview, most of industrial designers in Type A had the consensus that design should give people better life experience and satisfy or even please the user. It is also essential that products meet the ergonomic requirements and have quality. In addition, industrial designers in Type A placed emphasis on personal presentation skills. No statements in dimension of production and functional requirements were considered most important criteria. Besides two statements in affective aesthetics dimension, the statements considered most important by Type A subjects were evenly distributed in all dimensions. In Table 4,the standardized average factor scores of Type A industrial designers in six personal character dimensions fall between 4.380 to 5.600,with affective aesthetics dimension the top one (5.600) and basic requirements dimension the bottom one (4.380). There was no big difference among other dimensions and the radar diagram resembled to a regular hexagon. This indicated that industrial designers in Type A lay special emphasis upon the viewpoints of affective aesthetics but were in equal favor of other objective realistic conditions and personal skills. In other words, industrial designers in Type A tend to plan and care all aspects in product design.

4.1.2 Type B: Young and Equally Emphasize Fashion and Function

Eight subjects (16%, 4 males and 4 females) belonged to Type B, most of whom fell in the year range of 26-30. Basic profile of this type shows that they were young and junior in experience of product design.

The statements industrial designers in Type B considered most important and least important. Among them (Appendix A) , statements S05 “Design is aimed to bring forth people nice experiences in their life” and S29 “Product design should meet the security regulation” were considered most important by 4 subjects, with an average factor score of 7.798 and 7.841 respectively. Other statements statement S16 “Product design should meet the user’s ergonomic requirements,” S24 “Design calls for the quality of a product,” and statement S25 “Design is somewhat of a representation for the environmental protection concept.” On the contrary, statement S27 “The amount of man power invested in a project depends on the amount of one’s income,” was considered least important by Type B designers, with a low factor score of 1.613. Besides, other statements of least importance, included statements S08 “The masterpieces of famous designers will affect the aesthetics of my product design,” and S19 “The biomorphic approach to product form design brings fun to a product.” Overall, industrial designers in Type B cared a lot about the concept of environmental protection and whether the product meets safety regulation in addition to the requirements of design quality and ergonomics. Quite the opposite, they were not much interested in the biomorphic approach and masterpieces of famous designers in product form design.

From the statements Type B designers considered most important, subjects in this group cared quite a lot about safety regulation and design quality as well as the durability of products in addition to the consideration of environmental protection. It demonstrated that they paid much more attention to the production and functional requirements. In terms of the distribution pattern of most important dimensions of personal character, they were prominent in the dimensions of affective aesthetics and attitudes in behaviors.

From Table 4 and the radar diagram of Type B, subjects in this type were more prominent in dimensions of production and functional requirements (factor score 6.000), affective aesthetics (factor score 5.400) and attitudes in behaviors (factor score 5.125). In contrast, they were not evident in dimensions of personal skills (factor score 3.833) and product form manipulations (factor score 4.332) where the factor scores were lower and considered least important by more subjects. It is, therefore, evident that industrial designers in Type B emphasized the function of products. And because they were young in age and junior in design experience, they were referred to as a group that was practical and function-oriented.

4.1.3 Type C: Emphasize The Group's Benefit

Nine subjects (18%) were of Type C, 5 males and 4 females within the year range of 36-40. In terms of design experience, three were junior designers with experience less than one year and five with 1-3 years of design experience. Therefore, they were typical of junior product designers. From the statements designers in Type C emphasized (Appendix A), statements S29 “Product design should meet the security regulation” (factor score 7.225), S10 “Designers need to consider the balance between products and the environment” (factor score 7.402), and S25 “Design is somewhat of a representation for the environmental protection concept” (factor score 6.990) were the top 3 important factors. Other important statements such as S40 “The emphasis on marketing data analysis is an essential design procedure” (factor score 6.814) and S23 “Brain storming brings a wider variety to product design” (factor score 6.806) were also considered important. Quite the reverse, statements S46 “Doing a project alone demonstrates one’s self-value” (factor score 1.729) and S21 “It is better for a design to have the compliment of some design award” (factor score 2.073) were considered least important by five and four subjects respectively with standardized scores of 1 point. The ranking order of the importance of statements in Type C indicated that industrial designers in this type stressed a lot about the marketing and product planning at the early design state. They think highly of the needs of the enterprise but don’t care too much about their individual benefits and self values.

Subjects in Type C believed that it is essential to understand the market needs and to take marketing into consideration in product design and that it is necessary to draft a product planning. Meanwhile, they would never neglect the brain storming in a team and the regulations of quality and safety. Generally speaking, the issue of marketing in the dimension of basic requirements was the most important factor for Type C designers to consider in product design.

Among the six statements Type C designers considered most important, two belonged to attitudes in behaviors and other two belonged to affective aesthetics. Next to these two dimensions, one statement in basic requirements and one in production and functional requirements were also considered most important. On the contrary, there were two statements in affective aesthetics considered least important. Therefore, industrial designers in Type C tended to place top priority on the group’s benefit. From the distribution pattern of the standardized scores of six dimensions, there was no big difference among different dimensions. The average score of personal skills dimension in Type C was lower (factor score 4.000) while that of basic requirements dimension was higher (factor score 5.750).

4.1.4 Type D: Emotional Product Form and Personal Style Oriented

Six subjects (12%) joined Type D, with 5 males and 1 female at a year range of 20-35. On average, they had 8 years in product design experience and three of them had won design awards.

For the statements industrial designers in Type D emphasized (Appendix A), statements S05 “Design is aimed to bring forth people nice experiences in their life” (factor score 8.201) and S22 “The preliminary plan is a key factor to a successful design” (factor score 7.580) were the most important ones. In the next place were statements S47 “Product sketches can efficiently express a designer’s ideas” (factor score 7.026) and S14 “Design is aimed at showing outstanding attraction” (factor score 6.802), which belong to attitudes in behaviors dimension. In the least important statements, two belonged to basic requirements, including S21 “It is better for a design to have the compliment of some design award” (factor score 1.811), and S42 “The amount of man power invested in a project depends on the amount of one’s income” (factor score 3.239). Besides, two statements of personal skills, S45 “Design calls for the application of high technology” (factor score 1.950), and S48 “3D model construction and rendering are important in design proposals” (factor score 3.389), were also of least importance. This demonstrated that industrial designers in Type D didn’t consider the dimensions of basic requirements and personal skills significant in product design.

In their consideration of statements regarding product design, it is important that design can provide wonderful experience of life for users and that designers can apply unique designs to catch the consumer's eyes. In addition, they also paid much attention to product planning and idea sketches. Different from other types, no statements in dimensions of production and functional requirements and basic requirements were considered most important. On the contrary, one or two statements in these two dimensions were thought least important. In other dimensions of affective aesthetics, attitudes in behaviors and personal skills, each of them had two statements that were considered most important.

Moreover, the standardized scores and their radar diagram (Table 4) reflected a tendency to skew to the upper right, meaning that designers in Type D didn't think highly of the dimensions of production and functional requirements (factor score 4.111) and basic requirements (factor score 4.250). Therefore, this type of industrial designers were thought emotional and personal style oriented in product design.

4.1.5 Type E: Focus On The Realistic Aspects

Four males and four females (16%) belong to Type E industrial designers. Four of them were aged 26-30; three were 31-35; two were 36-40. In design experience, six of them had 1-3 years of product design experience; two had less than a year in product design experience. Particularly, five subjects in this type had been in charge of mechanical design and five had experience in graphic and multimedia design. On average, designers in Type E were older than those in other types but with design experience less than 3 years.

For the attitudes of industrial designers in Type E (Appendix A), the following statements were considered most important, including S16 "Product design should meet the user's ergonomic requirements" (factor score 7.638), S30 "Design makes it easy for users to operate a product" (factor score 7.308), S32 "Product form design should take mechanisms into consideration" (factor score 6.824), and S13 "The success of a design project lies in the communication between people" (factor score 6.541). This demonstrated that designers in Type E lay greater emphasis on product form manipulations and production, functional requirements and basic requirements. On the other hand, statements considered least important covered S21 "It is better for a design to have the compliment of some design award" (factor score 2.226), S27 "The amount of man power invested in a project depends on the amount of one's income" (factor score 2.561), and S45 "Design calls for the application of high technology" (factor score 2.697). Among these least important statements, the former two belonged to the attitudes in behaviors, which indicated that designers in Type E didn't think that the winning of design awards and the amount of income would influence their attitudes toward product design.

Among the statements concerning product design, industrial designers in Type E cared much about the operational function of a product and the combination of the mechanism and product form. Furthermore, subjects in this type concerned about interaction between product and users, brain storming, design budget, and the schedule of design projects. This indicated that designers in Type E placed much more emphasis on production and functional requirements than on other dimensions.

The distribution of standardized scores and their radar diagram (Table 3) show that the dimensions Type E designers considered most important covered affective aesthetics, product form manipulations, production and functional requirements, and basic requirements, which was consistent with the slanting lines in radar diagram. Among these dimensions, production and functional requirements had an average standardized score of 6.333, while personal skills dimension had an average standardized score of 3.500. To sum up, industrial designers in Type E cared more about product function and the production requirement. Therefore, they were considered as a group focusing on realistic aspects.

4.1.6 Type F: Well-Experienced and Aesthetics-Oriented In Product Form

There were only five subjects in Type F, the smallest group (10%). This group was composed of two males and three females. Three of them were aged 26-35 and two aged 41-45. Exceptionally, there were three senior designers in Type F, with more than 9 years of design experience. Moreover, four out of five in Type F had won some design awards. Four of them had the experience of graphic and multimedia design experience. Above all, four of them had been managers. The basic profile of this group indicated that Type F designers were senior designers with rich experience of design expertise.

The statements Type F designers considered most important were different from those of other types (Appendix A). Statements considered most important in Type F designers included S18 "A product design should have its own unique features" (factor score 8.450), S09 "Designers should carefully consider the aesthetic views of the target user group of a product" (factor score 7.204), and S43 "Design should take the budget and cost of a company into consideration" (factor score 6.874). The differences in the consideration of statements were due to the fact that the designers in Type F were older and senior in product design experience. On the other hand, the least important statements covered S45 "Design calls for the application of high technology" (factor score 2.393), S21 "It is better for a design to have the compliment of some design award" (factor score 2.615), S19 "The biomorphic approach to product form design brings fun to a product" (factor score 2.650) and S46 "Doing a project alone demonstrates one's self-value" (factor score 2.925). Two of these least important statements belonged to personal skills dimension.

From the opinions of Type F subjects, designers in this group thought that products should be different from the competitors, and that designers should take target user group's aesthetic points of view into account. In addition, they believed that affective design would become more and more important and that product design should include innovative functions. In contrast, designers in Type F didn't place much emphasis on personal skills dimension, with a remarkably low degree of importance. For the most important factors, there was at least one statement from each dimension except personal skills. With two statements considered most important, affective aesthetics dimension was the most emphasized aspect from the eyes of senior designers in Type F. At last, the least important statements evaluated by this group were centered on the attitudes in behaviors (2 statements) and personal skills (2 statements).

From the viewpoints of standardized scores (Table 4), affective aesthetics dimension had a highest score of 6.000 in Type F and basic requirements (5.875) the second. The standardized score of attitudes in behaviors (4.250) was not as low as expected. As mentioned above, the dimension personal skills was thought least important by Type F designers, with a standardized score of only 3.167, reflecting the missing corner in the radar diagram. Therefore, designers in Type F were referred to as well-experienced and aesthetics-oriented in product form.

4.2 Differences in The Job Allocation Among Different Types of Industrial Designers

The standard deviation in the viewpoints of six design attributes in designers that plan and care all aspects in product design (Type A) is smaller (sted=0.45). This indicates that designers in Type A are not partial to specific aspects of design activities and it will be easier for this type of designers to get along with other departments in an enterprise. Moreover, they are highly enthusiastic about design. Therefore, they are suitable for the coordination and management of design projects. And because they care about all aspects of design activity, they are not particularly aggressive in the product form manipulation. In handling a design project, they may not be suitable to be in charge of design projects that call for a high degree of innovation.

Designers in Type B are young and equally emphasize practical aspects and function. They often pay more attention to the issues of product quality, human factors and environmental protection. For this reason, they are not going to design products that are difficult to produce. On the contrary, they may work out product design that meets the requirement of production cost. Therefore, they are more suitable to be in charge of design projects where cost is the key issue.

However, because they are young in age and junior in design experience, they may need some other senior designers or managers to guide and offer help.
Designers in Type C place more emphasis on the group's benefit than their individual value and interest. For product design, they often care a lot about marketing survey and analysis in the early design stage. As a result, they are suitable to be responsible for data collection and analysis and the related design activities in a project.

Designers in Type D emphasize an emotional product form and personal style. They are the most creative and unique in design thinking among six types of designers. Because they care about different design skills, they are suitable for a totally new project and concept design that require distinctive points of view. Relatively, this type of designers do not emphasize production and functional aspects of products, so it is better that they are not put in charge of design projects that consider a lot about costs.

Type E designers focus on the realistic aspects of product design. They have a bigger deviation in the viewpoints of design attributes (sted= 1.14). Because they care about whether product function fits the requirements of production, they are suitable to be responsible for design projects where costs are of important consideration and risks are higher. This type of designers can complete design projects in a severe and dutiful manner.

Designers in Type F are experienced and aesthetics-oriented in product form. They also have a bigger variation in looking at design attributes (sted = 1.12). With rich experience in product design, Type F designers think highly of emotional aesthetics of product form but lay least emphasis on personal skills. Because they have rich design experience and care about affective aesthetics in product design, they are appropriate for product form design projects. The difference between Type F and Type D is that designers of Type D place less emphasis on production and functional aspects than Type F designers. For the redesign projects constrained by production conditions, it is better to put Type F designers that are well-experienced and product form oriented in charge.

4.3 General Discussions

In allocating designers for the cross-division design projects or small-scale redesign in regular projects in design departments, the job allocation model for industrial designers (Figure 1) can be used by design managers as a reference. Suitable designers can be selected for different design projects. The model of design job allocation is based upon six design attributes and characteristics of types of industrial designers in the radar diagram as well as the consideration of complexity in design projects, risks in the investment of product design, scale of production, and production cost of products.

In terms of the degrees of product form modification, the allocation of industrial designers should consider the following routine jobs: (1) product form redesign in serial products, (2) new product form with old functions, (3) totally new design, and (4) new concept design. The new concept design has the biggest degree in product form modification; totally new design the second; followed by the new product form with old functions; the serial product design has the lowest degree in product form modification. Because the scale and complexity in redesign of product form are smaller, it is suitable for independent work whereas a team work is more appropriate for other duties of higher degrees of innovation.

In allocating jobs to industrial designers, the following aspects should be also considered:
(1) Complexity in design projects, including aspects design projects are involved, involvement design and other departments have in design projects, difficulties of product development, and the like factors.
(2) Risks in investment: high risk indicates a bigger amount of investment, a higher product selling price, and a higher turnover in mass production.

(3) Quantity in production: a bigger scale in production for new products means a higher investment on the mold, manufacturing facility, production man power, causing a relatively larger risk to the business.
(4) Production costs: in launching a new product in the competitive market, the product cost should be put under strict control; otherwise the product will not be competitive in the market. Therefore, the strict control and saving in parts, mold, material and machining procedure can reduce the production costs and reinforce the product competition ability in the market.

In job allocation of industrial designers, the design managers are suggested to judge the innovation degree of jobs and the content of design projects. Then the design-oriented attributes of designers and characteristics in specific types can be used for the collocation of designers and design projects. The upper part of the radar diagram in the model of design job allocation is made up of affective aesthetics, product form manipulations, and personal skills (Figure 1). The higher tendency in these three design aspects indicates that designers emphasize a lot the emotional product form and that they are better in the jobs of new concept design and totally new design projects. Designers who place more emphasis on these three aspects are often more emotional and care less about cost and manufacturing. Therefore, it is suggested that they are assigned design projects of lower risk, lower investment, less complexity and looser schedule. The lower part of the radar diagram of the job allocation model is composed of attitudes in behavior, production and functional requirements, and basic requirements. Designers who emphasize these three aspects are more rational. Consequently, it is suggested that this type of designers take charge of projects for product form redesign in serial products and new product form with old functions. In addition, because of their realistic attitude toward product design, it is suggested that they are put in charge of projects with higher risks and investments or of projects where cost issue is essential, complexity is high, and schedule is tight. It is suggested that managers first figure out the property of designers in term of six design attributes and understand whether they belong to emotionally creative or rationally practical in their design attitudes. Then a specific type of designer in terms of design attitude can be identified. Furthermore, a proper design project can be assigned for designers in different types based upon the content of design jobs (Table 5) (refer to Section 4.2). In this way, each designer can make most of his or her talent to carry out the design project.

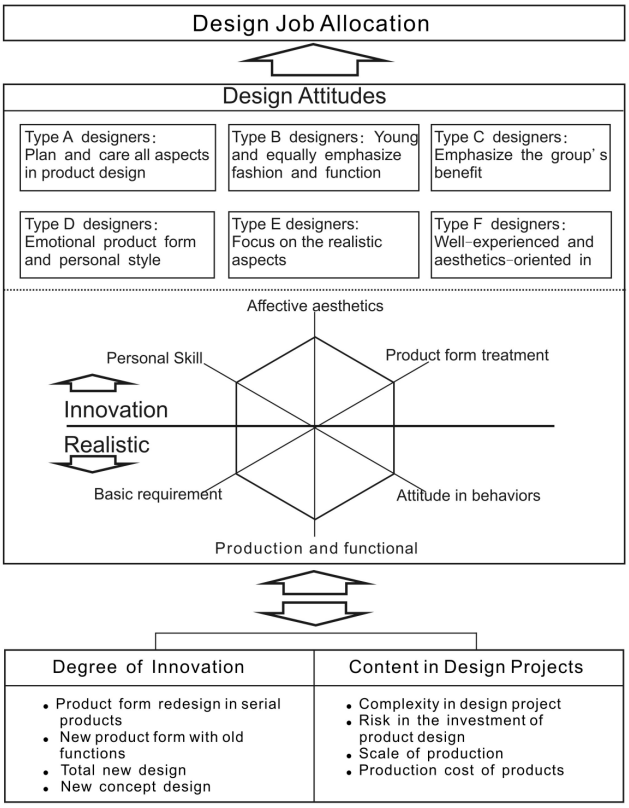

FIGURE 1: A job allocation model for industrial designers

	Tendency in attitudes toward design	Factors most emphasized	Features in personal character	Suitable jobs or projects	Notes
Type A designers: Plan and care all aspects in product design	Not partial to specific design attributes, not particularly ambitious in product form, but believed that design should bring people fun and offer them better life experience.	Place most emphasis on affective aesthetics but there is no big difference in all factors.	Enthusiastic about product design and will not cater to the market place with a compromising design due to the short amount of pay.	Project coordination job.	Not suitable for highly innovative projects.
Type B designers: Young and equally emphasize fashion and function	Design should meet the cost and production requirements.	Design quality and ergonomics are most emphasized; then they care about environmental protection and product safety regulation.	They will avoid designing products difficult to produce.	Projects where cost is important.	Junior in design experience.
Type C designers: Emphasize	Emphasize a lot the marketing	Marketing and product planning are highly	Don't care too much about their individual	Suitable for product planning or	Not very curious and weak in

the group's benefit	survey to help design projects.	emphasized.	benefits and self values.	research-oriented projects.	creativity.
Type D designers: Emotional product form and personal style oriented	Emphasize most the product aesthetics and creativity.	Consider product form manipulations and affective aesthetics most important.	Creative and unique in thinking but not careful in design routines.	Totally new and concept design projects.	Because they don't emphasize production requirements, they are not suitable to be in charge of projects where cost is dominant.
Type Edesigners: Focus on the realistic aspects	Take practical consideration into account in their design.	Emphasize most product function and production requirements.	Careful and businesslike in attitude.	Suitable for mass production and cost-oriented as well as highly risky projects.	They are pioneering and creative in design thinking.
Type F designers: Well-experienced and aesthetics-oriented in product form	Keep a balance in product form aesthetes, production and costs.	Affective aesthetics is most important.	Responsible and prudent; not good in social activity; not enthusiastic enough about design.	Most suitable for serial product design and redesign projects where cost factor is dominant.	Rich in design experience but don't emphasize personal skills.

TABLE 5.: Suggestions for the allocation of different types of product designers

Based upon the tendency and attitudes designers have toward product design as well as characteristics of projects in terms of innovation degree and content of design activity, jobs or projects suitable for different types of product designers are listed in Table 5. This can serve as a reference for design managers to select and assign designers for new projects or design duties.

5. CONCLUSIONS

In the present study, six types of industrial designers in their attitudes toward product design were specified from Q methodology. Based upon the attitudes designers have toward product design and their tendency in personal character, managers can select the appropriate members for a design team. From related studies, six dimensions of the skills and duties of industrial designers were induced, including affective aesthetics, product form manipulations, attitudes in behaviors, production and functional requirements, basic requirements, and personal skills. They were used to evaluate the category of design attitudes for the designers.

Type A industrial designers are young middle-aged generation with a certain period of design experience. The order of degree of importance they had toward product design is affective aesthetics > product form manipulations > personal skills > attitudes in behaviors > production and functional requirements > basic requirements. Generally, designers in this type care all aspects in product design, with approximately the same degrees of importance for all dimensions. Typically, industrial designers in Type A placed special emphasis upon the viewpoints of affective aesthetics and are highly enthusiastic about design.

Designers in Type B are young and equally emphasize fashion and function. Compared with other types of designers, they care a lot about production and functional requirements but place least importance on product form manipulations and personal skills. As a result, designers in Type

B are suitable to be in charge of design projects where costs are of greater importance because they will not work out difficult design proposals to meet the requirement of production cost. This type of industrial designers often pays more attention to practical issues such as product quality, human factors and environmental protection.

Designers in Type C emphasize the benefit of an organization. They considered aspects of product design in the order of basic requirements > attitudes in behaviors > production and functional requirements > product form manipulations > affective aesthetics > personal skills. Designers in Type C fell in a wide year range with design experience less than three years. They thought highly of basic requirements but least important for personal skills. With the group benefit in top priority, designers in Type C emphasized a lot about team work and were easy to get along with. But they might be a group of designers that were neither curious nor creative. Therefore, they are appropriate for being members in big-scaled design projects.

Industrial designers in Type D were emotional and personal style oriented in product form. They thought highly about product form manipulations and affective aesthetics but considered production and functional requirements and basic requirements least important. Because of the characteristic of being emotional and personal style oriented in product form, they were remarkably creative and unique in their product design. But they were least careful and tended to stick to their own ways of processing design routines. Accordingly, designers in Type D are suitable for totally new or conceptual design projects.

Focusing on the realistic aspects, designers in Type E emphasized production and functional requirements but didn't think highly of personal skills and attitudes in behaviors. Therefore, they can work out unique and creative products with solemn and well-disciplined state of mind. For this reason, designers in Type E are suitable to be allocated for design projects of which the risk is high.

Industrial designers in Type F were well-experienced and aesthetics-oriented in product form. The distribution of their age and design experience had two extremes. To them, affective aesthetics and basic requirements were the most important elements for product designers while personal skills were least imperative. Consequently, they could assume the full responsibility and consider all detailed aspects of product design due to the fact that they were the oldest group of designers. However, they did well in the performance of creativity. The only thing to desire is that they are not passionate enough so that they are not good in social intercourse. Such well-experienced and aesthetics-oriented product designers are suitable to be in charge of one-man projects, instead of controlling or coordinating the team work because they are often more cautious and introverted.

The identification of the designer's attitudes of product design and features in their personal character will help managers make most of the human resource. Managers at design department can categorize designers according to the feature of their attitudes toward product design. And based upon the quality of designers' attitudes and the innovation degree and complexity of design projects, appropriate industrial designers can be recruited or assigned for a team so as to complete the mission efficiently.

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Appendix A : Six dimensions and 50 statements of industrial designers' design attitudes

Dimension	No.	Statements	Factor score					
			Type A	Type B	Type C	Type D	Type E	Type F
A. affective aesthetics	S01	The fashionable messages should be endowed in the product design concept	3.72	3.59	3.79	5.34	4.10	5.54
	S02	A product design endowed with feelings will make it more attractive	5.63	6.23	5.13	6.31	6.31	6.79
	S03	Design is a concrete representation of our aesthetic experience	5.69	5.45	4.62	4.99	5.41	5.67
	S04	A beautiful appearance is an important factor to consider in product design	7.28	5.16	5.18	5.11	5.18	6.71
	S05	Design is aimed to bring forth people nice experiences in their life	7.41	7.80	6.73	8.02	6.50	5.58
	S06	Design is a transformation of personal tastes in products	5.52	4.79	3.35	4.41	4.38	4.36
	S07	Design needs to present the international point of view	4.57	5.56	3.81	5.40	3.57	5.83
	S08	The masterpieces of famous designers will affect the aesthetics of my product design	4.07	2.80	3.47	4.87	3.01	3.86
	S09	Designers should carefully consider the aesthetic views of the target user group of a product	4.79	4.06	5.72	5.71	5.23	7.20
	S10	Designers need to consider the balance between products and the environment	5.38	6.66	7.04	5.93	4.39	5.35
B. product form manipulations	S11	The form manipulations popular in the market will affect the design proposal	4.46	3.58	4.23	6.03	4.99	5.69
	S12	Design applies form elements to express the product semantics	5.16	3.88	5.37	6.32	4.72	4.63
	S13	Product form design should make users feel fun and enjoyable	6.80	4.48	5.03	5.87	6.43	6.28
	S14	Design is aimed at showing outstanding attraction	6.15	4.81	3.78	6.80	4.20	5.01
	S15	Design is a shape combination that features harmony	4.94	5.43	4.87	5.98	5.27	4.63
	S16	Product design should meet the user's ergonomic requirements	6.35	7.59	6.54	5.98	7.64	4.76
	S17	Design is a subtle combination of geometric elements	3.33	4.05	3.58	4.54	3.50	3.76
	S18	A product design should have its own unique features	6.19	5.13	5.39	4.08	5.52	8.45
	S19	The biomorphic approach to product form design brings fun to a product	3.85	2.74	4.10	3.54	3.37	2.65
C. attitudes in behaviors	S20	The description of design concept is a key factor in the design process	6.42	5.59	5.19	5.48	5.36	5.42
	S21	It is better for a design to have the compliment of some design award	4.74	3.71	2.07	1.81	2.27	2.62
	S22	The preliminary plan is a key factor to a successful design	5.10	6.53	6.72	7.58	5.56	6.75
	S23	Brain storming brings a wider variety to product design	4.39	4.16	6.81	6.55	5.84	3.63
	S24	Design calls for the quality of a product	6.32	7.57	5.94	6.25	4.44	5.42
	S25	Design is somewhat of a representation for the environmental protection concept	4.52	7.19	6.90	4.11	3.64	6.63
	S26	Design is a sharing of proposals and a search of suggestions	4.63	4.31	4.85	5.68	5.70	3.75

	S27	The amount of man power invested in a project depends on the amount of one's income	2.15	1.61	4.28	3.24	2.56	2.94
D. production and functional requirements	S28	A design proposal should have an innovative function	5.48	4.82	4.65	5.54	5.26	6.74
	S29	Product design should meet the security regulation	5.98	7.84	7.23	4.30	6.10	5.07
	S30	Design makes it easy for users to operate a product	5.83	6.38	5.94	5.02	7.04	5.70
	S31	Design should consider the durability of products	4.12	5.75	4.93	3.62	5.11	3.98
	S32	Product form design should take mechanisms into consideration	5.42	4.80	5.83	4.71	6.82	4.90
	S33	Design should consider the ease of manufacturing	5.09	4.91	4.86	4.22	5.57	4.07
	S34	Design should consider the maintenance of a product	4.88	5.31	5.05	4.31	5.55	4.02
	S35	A product design with simplification of materials will meet user's expectation	4.06	4.71	5.02	3.57	4.98	3.18
	S36	Design makes possible the integration of complex functions	2.95	5.94	3.84	4.11	6.14	5.78
E. basic requirements	S37	The success of a design project lies in the communication between people	4.94	5.90	4.86	5.68	6.54	4.88
	S38	Design project should follow the timing schedule	4.17	5.21	5.51	3.76	6.48	6.10
	S39	Design should work out a compromising proposal that meet requirements of different parties	1.89	4.46	3.61	3.81	3.60	4.96
	S40	The emphasis on marketing data analysis is an essential design procedure	6.32	6.11	6.81	5.89	6.15	5.80
	S41	Design should take marketing into consideration	5.50	5.51	6.02	3.58	6.06	5.27
	S42	Design is a thinking process oriented toward the boss's preferences	3.11	3.09	3.96	3.16	4.38	4.36
	S43	Design should take the budget and cost of a company into consideration	4.84	4.66	5.69	4.14	6.10	6.87
	S44	Design should consider the corporate identity of an enterprise	5.42	4.63	6.12	6.02	4.63	6.26
F. personal skills	S45	Design calls for the application of high technology	3.54	3.40	2.98	1.95	2.70	2.39
	S46	Doing a project alone demonstrates one's self-value	2.98	3.84	1.73	5.38	4.07	2.92
	S47	Product sketches can efficiently express a designer's ideas	6.18	5.47	5.75	7.03	4.97	4.79
	S48	3D model construction and rendering are important in design proposals	6.15	4.69	5.05	3.39	4.54	3.13
	S49	Models should be able to precisely express the product form	6.01	3.68	5.87	4.54	4.20	4.42
	S50	Design is a representation of personal style and taste	5.56	4.45	4.22	6.33	3.94	4.49