LEARN X DESIGN 2021
Engaging with Challenges in Design Education
6th International Conference for Design Education Researchers
Shandong University of Art & Design | Jinan, China

# Study on the Implementation of the Innovative Enterprise Product Design Model for ID Students

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https://doi.org/10.21606/drs_lxd2021.10.181

Industrial design education often prompts students to focus on creativity and user needs, and lacks knowledge and concepts in marketing and sales. Thus, this study proposed the "Innovative Enterprise Product Design Model" and planned a teaching course to teach the theoretical knowledge and application methods of this design model. Solving the problem where students' designs are often out of touch with the industry. This study is divided into three stages. The first stage invites industrial design students to carry out product design using this design model. The second stage invites experts to evaluate the students' design results. For the third stage, students are invited to fill in the feedback questionnaire. According to the study results, the students believed that they performed well and improved their innovation ability, product strategy formulation, and design maturity. They were also able to master the operation of the design model. The experts also believed that the design achievements were excellent in all aspects. And the results also proved the feasibility of this design model.

Keywords: development strategy; design education; design model; Industrial Design

## 1. Introduction

The cultivation of industrial design education is a profound subject, and compared with other fields such as science, humanities and business management, design studies are not as clearly defined. With the evolution of the times, the field of industrial design is no longer limited to the exploration of products, but has expanded to service design, experience design, sustainability design, and social design, which studies the interaction between products and the environment, systems, experiences and services (Yenilmez & Bagli,2020). In recent years, the field of industrial design has become increasingly focused on achieving the goal of a circular economy (van Dam et al.,2020), which highlights its complexity, thus the education on design needs to emphasize the incorporation of interdisciplinary knowledge into the curriculum.

When faced with different design issues, designers need to consider the present market conditions, user requirements, and explore the engineering technology of the product. More importantly, the design proposal must have a certain degree of "feasibility." In order to elevate the competitiveness of innovative products in the market, it is necessary to focus on the relationship between marketing, industrial design, and engineering technology during the design and development stage (Veryzer, 2005), such as the estimated cost of sales the products, technical feasibility, and product market positioning. Micheli et al. (2012) believe that the development of an innovative product requires the cooperation of experts in different fields. In addition to the aesthetics, functions, and materials of the product, designers must also pay attention to the commercial aspect of the product, which means that in addition to considering the desired product appearance from the user's perspective, a mature product also needs to take into account the enterprise's philosophy, resources, sales strategies, and market positioning from the perspective of the enterprise, since a product will only achieve stable profits in the market by understanding the needs and positioning of both the consumer and enterprise. However, the development of industrial design education often prompts students to focus on creativity and user needs, and lacks knowledge and concepts in marketing and sales, as well as the

understanding of the company's organizational structure and the business model of products, which results in an insufficient level of maturity in the design by the students. Owing to the aforementioned factors, the final design is often too impractical, and fails to meet industry design standards.
The purpose of design is to resolve problems. To this end, the process of innovative design requires integrating, coordinating, and articulating various design elements (Alonso-García et al., 2020) to further refine the design results in each aspect. Innovative thinking is also an essential ability in the design field. Creative thinking enables designers to pursue solutions to design problems, and design educators must consider guiding students in mastering this ability through means and learning activities (Balakrishnan, 2021). Through sophisticated course arrangements, academic content and pragmatic knowledge are transformed into a vivid thinking model that helps students implement thinking in a smoother manner, reflect on the definition of design, and achieve the goal of good design (Andreasen,2011).
To make up for students' shortfalls incomprehensive design thinking and improve the feasibility of students' product design, this study proposed the "Innovative Enterprise Product Design Model" and planned a six-week teaching course to teach the theoretical knowledge and application methods of this design model. It is hoped that this will help design students to improve their innovative design ability and insight into consumer needs, and at the same time to solve the problem where students' designs are often out of touch with the industry.

## 2. Innovative Enterprise Product Design Model

Based on the author's years of teaching experience in the field of design, students in industrial design often emphasize the "design approach" or the "aesthetics of design" during the design process. Thus, they are accustomed to implementing designs according to user needs or focusing on the functions, shapes, and materials of the product; these students are often less concerned about enterprise limitations when developing innovative products. To encourage students to think comprehensively from the perspective of users and enterprises while also elevating the feasibility of their design proposals, the Innovative Enterprise Product Design Model proposed in this study departs from the perspective of enterprise thinking. At the same time, this design model is proposed by the three authors of this study, and the operation process is divided into three major stages. Starting from the design thinking of "who are we?", the design methods and scope of thinking enable students to consider the enterprise and market orientations in design before proceeding to "design approach" and "excellent design" concepts to gradually complete the design task (see Figure 1). In addition, this design model is a conceptual design toolbox, allowing the user to use the appropriate method flexibly at each stage of design.

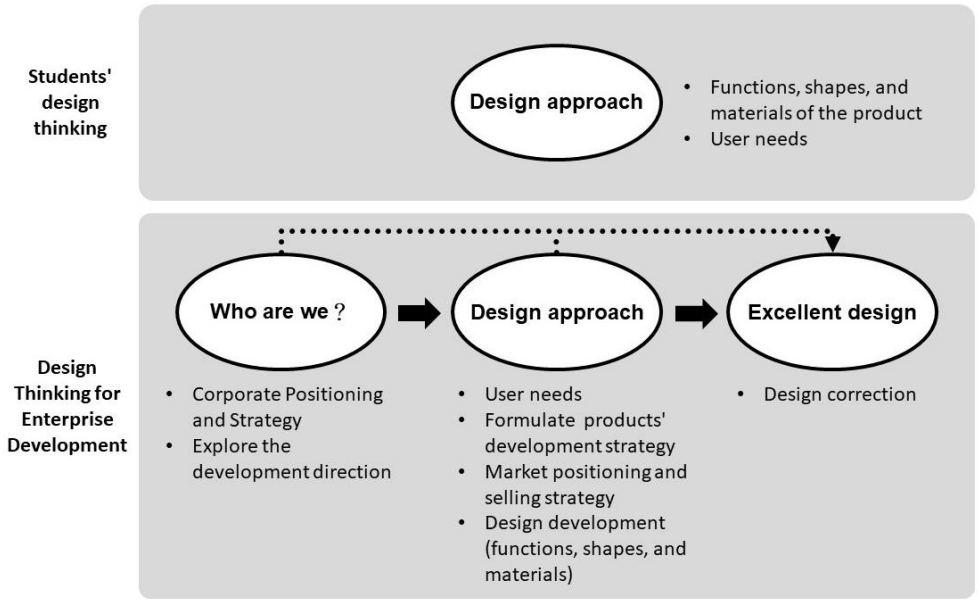


*Figure 1. The difference between development thinking from an enterprise perspective and the design thinking from a student perspective*

The "who are we" stage primarily explores the relationship between the enterprise, the market, and the users, and helps students to understand the existing market positioning of the enterprise and its resources, as well as

find a feasible product development direction. The “design approach” stage formulates the development strategy of innovative products from the research results obtained from the previous stage, and proposes the design that satisfies the enterprise’s development feasibility and the needs of users in regard to products and marketing. The final stage of “excellent design,” in addition to the development of a specific design result, the design result is checked to ensure it conforms to the design strategy through the use of design tools and methods, and then it is gradually modified to achieve maturity. The design model proposed in this study is shown in Figure 2. The following sections will introduce the tools and implementation processes used by each developing procedure.

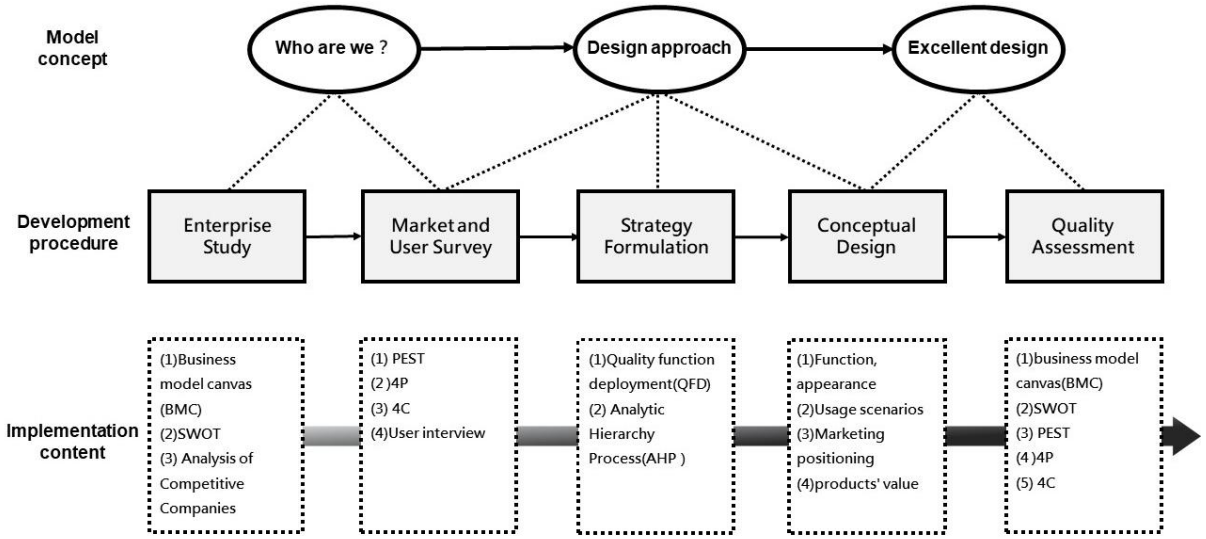


*Figure 2. Development procedure and implementation content of the “Innovative Enterprise Product Design Model”*

## 2.1 Enterprise Study

The beginning of the design stage involves learning about the types of products that can be developed to maximize both feasibility and enterprise profits. Therefore, the Enterprise Study stage is mainly focused on the nature of the enterprise. For enterprises, stable profits and continuous innovation are crucial factors. In addition to the efforts of the enterprise team, methods and tools are required for planning and for study. This study has researched academic literature and discovered numerous relevant methods and tools. Among them, the business model canvas (BMC) method has received considerable attention and is the most commonly used tool for the inspection of enterprise operation profiles. In this method, the value creation, value delivery, and value acquisition of a commercial system as well as the operation system are visualized and divided into the following nine segments: customer segments, value proposition, channels, customer relationships, revenue streams, key resources, key activities, key partnership, and cost structure. BMC helps organizations clearly analyze their current situation and conduct more efficient internal communication (Osterwalder & Pigneur, 2010; Koprivnjak & Oberman Peterka,2020; Das et al., 2020; Hamwi et al., 2021). Strengths, weaknesses, opportunities, and threats (SWOT) analysis is a common management decision-making method that has been applied in various industries and enterprises, such as in management analysis of the fishery industry (Haapasaari et al., 2021) and the automobile industry (Li et al., 2020). The method has a two-dimensional structure that is used to identify relevant internal and external factors; when successful, this method helps businesses avoid incorrect strategy decisions through analysis and establish feasible strategies (Rousseau & Rousseau, 2021), which makes it a suitable tool.

Hence, the specific procedure of this model uses the BMC tool to analyze the current business operation model and the value provided by the enterprise, and analyze the positioning of the enterprise in the designated field, as well as the product strengths, weaknesses and company strategies of its competitors regarding external factors of the company. The SWOT analysis method is also utilized at the same time to analyze the existing strengths, weaknesses, opportunities, and threats from a macro perspective.

## 2.2 Market and User Survey

The “Market and User Survey” stage probes into the existing products currently sold by the enterprise, and

discusses the positioning, strengths, weaknesses and actual consumer experience of these products in the market to facilitate the formulation of subsequent development strategies.
PEST analysis is a method used to analyze macro trends such as politics, economic, social, and technology. This method provides a thinking framework that facilitates understanding of phenomena such as business operations, industry, and market growth cycles, which is why this analysis method is adopted to explore the opportunities and limitations in the development of existing product categories. The 4P analysis is then used to analyze the current status of competing products regarding price, product, promotion and place that will identify the feasible innovation opportunities and design constraints for the future innovative products of the enterprise. Thereinafter, the 4C analysis method is used to explore the products currently sold by the enterprise in terms of consumer's needs, cost, convenience, and communication from the consumer's perspective, and identify the design requirements and feasible opportunities for the future innovative products of the enterprise. After completing the above analytical steps, an interview outline based on the analysis results is formulated to thoroughly interview the needs of product users.

### 2.3 Strategy Formulation

The analysis results of the "Enterprise Study" and "Market and User Survey" indicate the product categories that are most feasible for the enterprise, thus the design team will jointly decide the product category to be developed in this stage, and set forth the design requirements and feasible engineering technologies for innovative products.
Quality Function Deployment (QFD) is a method used to ensure that customer needs can be converted into design objectives or engineering technology through quantitative calculation, where Pullman et al. (2002), Marsot (2005), Ginting & Ali (2016) and Mistarihi et Al. (2020) had also applied this method to product research, which illustrates the applicability of this method in the field of design. Therefore, this design model will use QFD for development and design, and calculate the order of importance for various engineering technologies that will be used as the optimal strategy for subsequent development and design. In addition, Analytic Hierarchy Process (AHP) is widely applied to solve decision-making and planning issues, and systematizes problems through hierarchical and quantitative methods to reduce the risk of failure (Saaty, 1977; Kutlu Gündoğdu et al., 2021); at the same time, this method is able to calculate the weight of various indicators. Hence, this method is adopted to calculate the weight of design requirements in the house of quality.

### 2.4 Conceptual Design

At this stage, the most feasible technologies among the top rankings according to the importance of the engineering technology as the design strategy for product development. Then, begin to design product functions, appearance, usage scenarios, or service experience, as well as formulate the market positioning and product value.

### 2.5 Quality Assessment

This stage uses methods, including BMC, SWOT, PEST, 4P and 4C, to determine whether the innovative product conforms to the design guidelines and market strategy before implementing adjustments and revisions.

## 3. Study Method

### 3.1 Study Flow

This study is divided into three stages. The first stage invites industrial design students to carry out product design using this design model. The second stage invites experts to evaluate the students' design results. For the third stage, students are invited to fill in the feedback questionnaire that will facilitate understanding of the influence of this design model on students' design ability.

### 3.2 Implementation Planning on the Operation of the Design Model

This study plans for a six-week teaching curriculum to teach students the theory and application of the design model, and gives students five weeks for data analysis, collection, and product design. The plan is shown in Figure 3. The design theme of this study is to "design a completely new line of products for the enterprise." The choice of the enterprise is decided by the students. The participants of the design activities are 26 graduate and undergraduate students from the industrial design department of a certain university in Taiwan.

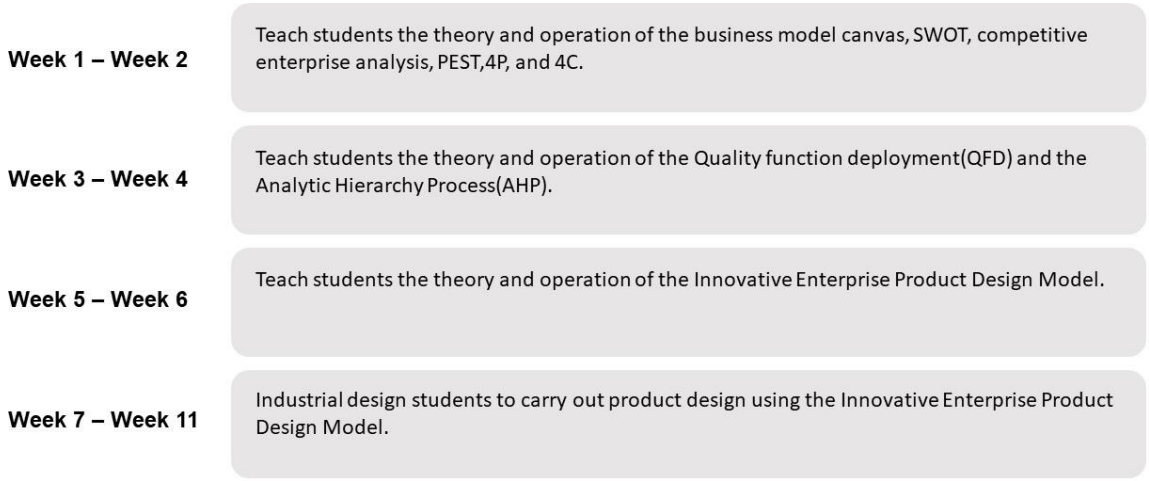


*Figure 3. Curriculum of this study*

## 3.3 Expert Evaluation Planning

This stage invites three experts in design education with an average of over five years of teaching experience to jointly formulate the evaluation criteria for the design results and the evaluation criteria weighting. The evaluation criteria are: E1-Products have market segmentation and positioning, E2-Products have usability, E3-Products meet the needs of target users, E4-Products attract consumer's desire to purchase, E5-Products conform to the spirit of enterprise values, and E6-Products are feasible for the enterprise.

Although the evaluation criteria for the student work has been finalized, it is difficult to provide a precise quantitative score for the strengths and weaknesses of the design work. This means that the behavior of scoring contains fuzzy attributes to a certain degree. Fuzzy comprehensive evaluation (FCE) is an evaluation method based on the Fuzzy theory, which can be used to evaluate all things with fuzzy attributes and transform qualitative evaluation into quantitative evaluation (Chueh,2001; Zhang &Feng,2018), and is also applied to the evaluation of product assembly design and operability (Ko, 2019), and that is why this study has chosen this method to evaluate the students' design work.

Next, 60 experts with a background in design or marketing management are invited to evaluate the students' design results according to the evaluation criteria. The evaluation method is conducted in the form of an online questionnaire. After the experts had read the design drawings and design descriptions, the design proposals are evaluated by the six evaluation criteria (E1-E6). The questionnaire rating scale was set as very bad, not good, fair, good, very good, with a total of 5 grades, expressed as V={V1,V2,V3,V4,V5}={very bad, bad, fair, good, very good}. Next, the evaluation results are established into a factor evaluation matrix. Finally, FCE is used to calculate and obtain a comprehensive evaluation result of each student's work.

## 3.4 Planning of Student Feedback Questionnaires

Three design education experts with an average of over 5 years of teaching experience jointly designed the questionnaire, which focused on innovation ability, the effectiveness of the design model, and operability. The questionnaire consisted of 9 questions (Table 1). All the student participants (26 students) completed the questionnaire after the study's design activity was completed.

*Table 1. Design Model feedback questionnaire*

| *Aspect* | *Question* |
|---|---|
| A. Innovative design ability | A1. Does this design pattern elevate your innovative design ability for your design? |
| B. Design model effectiveness | B1. Does this design model help you in clarifying the current status and the design and development direction of the enterprise affiliated with your design?<br>B2. Does this design model help you in realizing the needs of the users and the market for your design?<br>B3. Does this design model help you in formulating the design and development strategy for your design?<br>B4. Does this design model help you in increasing the design-conception ability for your design?<br>B5. Does this design model help you in evaluating the quality of the design result for your design? |
| C. Operability | C1. How was the operability for the actual implementation of this design model? |

## 4. Result and Discussion

### 4.1 Expert's evaluation on the design result

There are 64 experts in the evaluation questionnaire. Gender distribution: 34 male and 30 female experts. Age distribution: 21 experts are 21-30 years old, 36 experts are 31-40 years old, and 7 experts are over 41 years old. Professional field distribution: 36 experts are in the design field, and 28 are in marketing management. Education level distribution: 7 experts graduated from university/college, 48 experts hold a master's degree, and 9 experts hold a doctorate degree. Years of experience in design education: 11 experts have less than 5 years, 1 expert has 6-10 years, and 4 experts have over 10 years. Years of experience in marketing management education: 13 experts have less than 5 years, 2 experts have 6-10 years and 1 expert has over 10 years. Years of work experience in the related fields of product design, product planning, and marketing management: 36 experts have less than 5 years, 10 experts have 6-10 years, and 8 experts have over 10 years. In this study, the FCE method was used to analyze the students' designs. The calculation formula is:

$$\widetilde{B} = \widetilde{\mathrm{A}} \circ \widetilde{\mathrm{R}} = (a_1, a_2, \dots, a_m) \circ \begin{pmatrix} r_{11} & \cdots & r_{1n} \\ \vdots & \ddots & \vdots \\ r_{m1} & \cdots & r_{mn} \end{pmatrix} = (b_1, b_2, \dots, b_n), b_j = \bigvee_{i=1}^{m} (a_i \wedge r_{ij}) \text{ , (j} = 1,2, \dots, \text{n)}$$

In this study, the vector $\tilde{A}$=$(0.286 \quad 0.143 \quad 0.095 \quad 0.238 \quad 0.048 \quad 0.190)$ is the weight of design requirements, which was jointly developed by three design education experts through a voting process, and $a_t$ refers to the importance weight of the evaluation criteria($1 \leq \mathrm{t} \leq 6$). Factor evaluation matrix $\widetilde{\mathrm{R}}$ is a matrix created by summing and standardizing the results of the expert questionnaires. The value $r_{mn}$ $(m = 1,2, \cdots ,6; n = 1,2, \cdots ,5)$ in the matrix refers to the percentage of votes for the nth rating scale in the mth evaluation criterion.

In addition, the works from two groups of students have been selected from a total of eight groups for analysis and discussion due to the limitation of the length of this study. The results are shown as follows.

1. *Designing a sports first aid kit for GIANT (Figure 4.)*

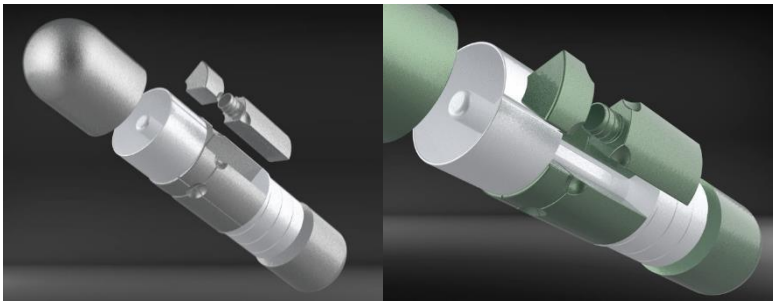

*Figure 4. Gi-Aid sports first aid kit*

- Design background and motivation: GIANT is a leading Taiwanese bicycle brand that emphasizes user-friendly designs that focus on “humanism,” and that a bicycle is not merely a transportation tool but a high-level pursuit in people’s daily lives. In the design pattern analysis, the student participants discovered that the number of people using bicycles for transport has been gradually increasing and with it the possibility of injury, which is when first aid kits are useful. Conventional first aid kits are neither convenient nor aesthetically pleasing; thus, the goal was to design a lightweight, trendy, health-protecting, and convenient first aid kit as well as to promote public awareness of health care and disaster prevention.
- Target group: The target group for the product is those with a relatively high disposable income who enjoy leisure and outdoor exercise.
- Product function and specification: The design highlights the redistribution and modularization of space utilization, resulting in a first aid kit tailored to the target group that subverts existing perceptions of first aid kits.
- Selling price and promotion: The product will be priced at roughly NT$1000 and sold in specialty stores, retailers, and on the official website (accessories section). Authoritative individuals with medical backgrounds will be invited to endorse the product. Bloggers will be invited to review and recommend the product, and social media platforms will be used to enhance public impressions of the product. A monthly rental maintenance service will be offered for the kit after purchase.

Factor evaluation matrix is as follows:

$$\widetilde{R_1} = \begin{bmatrix} 0 & 0.031 & 0.141 & 0.641 & 0.188 \\ 0 & 0.031 & 0.203 & 0.516 & 0.250 \\ 0 & 0.016 & 0.219 & 0.547 & 0.219 \\ 0.016 & 0.047 & 0.359 & 0.422 & 0.156 \\ 0 & 0.047 & 0.188 & 0.625 & 0.141 \\ 0 & 0.031 & 0.156 & 0.578 & 0.234 \end{bmatrix}$$

According to the statistical results, the experts suggested that, in terms of the design results in the aspect of “E1” evaluation criteria, the evaluation of 82.9% of the experts were good and very good. A total of 76.6%, 76.6%, 57.8%, 76.6%, and 81.2% of the experts evaluated the design results as “good” and “very good” for the dimensions of “E2,” “E3,” “E4,” “E5,” and “E6,” respectively. Next, this study calculated the FCE, and the calculation process is as follows:

$$\widetilde{B_1} = (0.286 \quad 0.143 \quad 0.095 \quad 0.238 \quad 0.048 \quad 0.190) \circ \begin{bmatrix} 0 & 0.031 & 0.141 & 0.641 & 0.188 \\ 0 & 0.031 & 0.203 & 0.516 & 0.250 \\ 0 & 0.016 & 0.219 & 0.547 & 0.219 \\ 0.016 & 0.047 & 0.359 & 0.422 & 0.156 \\ 0 & 0.047 & 0.188 & 0.625 & 0.141 \\ 0 & 0.031 & 0.156 & 0.578 & 0.234 \end{bmatrix}$$

$$= (0.016 \quad 0.047 \quad 0.238 \quad 0.286 \quad 0.190)$$

The FCE vector$(0.016 \quad 0.047 \quad 0.238 \quad 0.286 \quad 0.190)$as processed using normalization calculation, and the result was $(0.021 \quad 0.060 \quad 0.306 \quad 0.368 \quad 0.245)$.According to the results, the design was evaluated as very good (24.5%), good (36.8%), fair (30.6%), bad (6%), and very bad (2.1%). This study interpreted the results from the perspective of the maximum degree of membership, the experts' evaluation of this design proposal reached a "good" level.

2. *Designing a home robot vacuum for Tesla Inc. (Figure 5)*

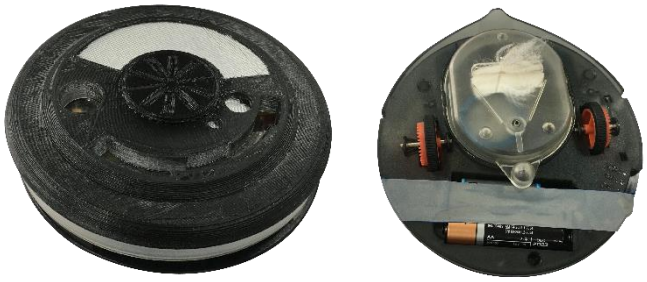

*Figure 5. Intelligent Robot Vacuum*

- Design background and motivation: Tesla is a leading American brand in electric vehicles with advanced battery technology and driving systems. The company focuses environmental protection and safety issues, while also ensuring that consumers enjoy high quality services. After analyzing and discussing through this design model, it is found that other manufacturers are currently pushing the electric vehicle market and are gradually catching up to Tesla's battery technology. At the same time, Tesla products are expensive with few maintenance sites and charging stations, which limits the consumer group to specific targets. In order to cultivate the image of Tesla and extricate the brand from the existing market that will generate additional targets for the brand, this proposal decided to design a unique robot vacuum that combines technology, innovation, environmental protection, and luxury, in the hope that consumers will enjoy a highly efficient and convenient clean environment, as well as experience a sense of luxury with the Tesla brand.
- Target group: Tesla drivers, high-income groups and busy consumers.
- Product function and specification: This product adopts Tesla batteries and is equipped with three wheels; two are driving wheels, and the third is a universal wheel. The product sensors, such as the drop-proof sensing device and a coding odometer, utilize infrared, visual, and ultrasonic transmission. The terminal processor uses printed circuit board assembly technology, and the cleaning structure includes a side brush, rolling brush, and garbage bin. Additional modules include a laser distance sensor module, a visual simultaneous localization and mapping sensor module, and a CleanBas self-cleaning base.
- Selling price and promotion: The predetermined price is about NTD 15,000, and will be sold in specialty stores and through online e-commerce. It will be advertised through TV advertising, social media platform launch, audio-visual platform advertising, industry distributions, endorsements, etc.

Factor evaluation matrix is as follows:

$$\widetilde{R_2} = \begin{bmatrix} 0.047 & 0.234 & 0.250 & 0.422 & 0.047 \\ 0 & 0.125 & 0.297 & 0.453 & 0.125 \\ 0 & 0.125 & 0.422 & 0.406 & 0.047 \\ 0.047 & 0.219 & 0.266 & 0.391 & 0.078 \\ 0.031 & 0.125 & 0.438 & 0.359 & 0.047 \\ 0.031 & 0.156 & 0.297 & 0.391 & 0.125 \end{bmatrix}$$

According to the statistical results, the experts suggested that, in terms of the design results in the aspect of "E1" evaluation criteria, the evaluation of 46.9% of the experts were good and very good. A total of 57.8%, 45.3%, 46.9%, 40.6%, and 51.6% of the experts evaluated the design results as "good" and "very good" for the dimensions of "E2," "E3," "E4," "E5," and "E6," respectively. Next, this study calculated the FCE, and the calculation process is as follows:

$$\widetilde{B_2}=(0.286 \quad 0.143 \quad 0.095 \quad 0.238 \quad 0.048 \quad 0.190)\circ \begin{bmatrix} 0.047 & 0.234 & 0.250 & 0.422 & 0.047 \\ 0 & 0.125 & 0.297 & 0.453 & 0.125 \\ 0 & 0.125 & 0.422 & 0.406 & 0.047 \\ 0.047 & 0.219 & 0.266 & 0.391 & 0.078 \\ 0.031 & 0.125 & 0.438 & 0.359 & 0.047 \\ 0.031 & 0.156 & 0.297 & 0.391 & 0.125 \end{bmatrix}$$

$$= (\ 0.047 \quad 0.234 \quad 0.250 \quad 0.286 \quad 0.125\ )$$

The FCE vector$(\ 0.047 \quad 0.234 \quad 0.250 \quad 0.286 \quad 0.125\ )$as processed using normalization calculation, and the result was $(0.050 \quad 0.248 \quad 0.265 \quad 0.303 \quad 0.133\ )$.According to the results, the design was evaluated as very good (13.3%), good (30.3%), fair (26.5%), bad (24.8%), and very bad (5%). This study interpreted the results from the perspective of the maximum degree of membership, the experts' evaluation of this design proposal reached a "good" level.

### 4.2 Result of student questionnaire feedback

A total of 26 students have submitted the learning feedback questionnaire, including 10 males and 16 females. There were 21 sophomores (80.8%), 3 juniors (11.5%) and 2 masters (7.7%). The questionnaire is divided into innovative design ability, design model effectiveness, and operability. The statistical results are as follows.

*1. Innovative design ability*

In question A1, 23.1% of the students stated they achieved a very high degree of elevation in “innovative design ability,” 38.5% stated high, 26.9% said medium, 7.7% stated slightly low, and 3.8% stated low.

*2. Design Model effectiveness*

In question B1, 30.8% of the students stated that this design model had provided a very high degree of help in “clarifying the current situation of the affiliated enterprise and the direction of enterprise’s design and development.” 61.5% stated high, 3.8% stated medium, and 3.8% stated slightly low. No one selected the option of low degree of help. In question B2, 34.6% of the students stated that this design model had provided a very high degree of help in “identifying users and market needs,” 53.8% stated high, 7.7% stated medium, 3.8% stated slightly low. No one selected the option of low degree of help. In question B3, 38.5% of the students stated that this design model had provided a very high degree of help in “formulating their design and development strategy,” 46.2% stated high, 15.4% stated medium. No one selected the options of slightly low and low degree of help. In question B4, 15.4% of the students stated that the design model had provided a very high degree of help in “enhancing design concept,” 26.9% stated high, 42.3% stated medium, and 15.4% stated slightly low. No one selected the option of a low degree of help. In question B5, 26.9% of the students stated that the design model had provided a very high degree of help in “evaluating the quality of design results,” 46.2% stated high, 19.2% stated medium, and 7.7% stated low. No one selected the option of low degree of help.

*3. Operability*

In question C1, 23.1% of the students stated that the operability of this design model was very high, 30.8% stated high, 34.6% stated medium, 11.5% stated slightly low. No one selected the option of low degree of help.

*4. Discussion of statistical results*

The statistical results show that in the aspect of improving innovation ability, more than half of the students (61.6%) believed that the use of this design model provided a significant level of positive help when developing innovative products and services for enterprises. This also represents that this design model formulates design strategies from the thought perspective of enterprises and users, and combines the design with the QFD method that facilitates outstanding results in innovative performance for students. Regarding the effectiveness of this design model, students believe that the design model provides the most significant help in clarifying the current situation of the affiliated enterprise and the design and development direction of the enterprise (92.3%). The second highest ranking is insight into the needs of the users and the market (88.4%). Third highest is formulation of the design and development strategy (84.7%), and the fourth is to evaluate the quality of design results (73.1%). The last is to increase the design concept (42.3%). From the results, it can be seen that this design model can help design students by equipping them with a more systematic approach in identifying the needs of the enterprise regarding product development during the early stages of design, and understand the positioning of the enterprise’s existing products in the market, such that they can formulate

the development direction and strategies for subsequent innovative products. Simultaneously, it also proves that this design model can strengthen students' deficiencies in business analysis and marketing planning. However, this model is relatively weak in the aspect of increasing innovative ideas. Finally, regarding operability, 53.9% of the students stated that the design model has excellent operability, and most of the students were able to master the main techniques of the method from the six-week curriculum study. Although the learning process was rather arduous as it took a lot of time to collect and analyze data during the early stages of design implementation, this method can still help students in systematically speculating the direction of product development and design products that meet market needs.

## 5. Conclusion and Suggestions

An excellent designer is able to precisely define the appropriate scope of problems, properly prioritize the problems to be explored, and focus on the design solution (Cross,2004). For students, precisely defining design issues and restricting the scope of the relevant issues is relatively difficult, for doing so requires prolonged cultivation and guidance from teachers. Furthermore, stipulating design strategies from the marketing perspective as well as producing designs that truly conform to market expectations, from product development to final sales, is essential. The development of innovative commodities increasingly emphasizes interdisciplinary teamwork (Micheli et al., 2012). Design schools must cultivate interdisciplinary communication and coordination abilities as well as arrange opportunities for students to cooperate with the industry or to implement design plans with students from different fields (Yenilmez & Bagli,2020), which prepares students to thrive in the industry after graduation. However, in reality, design courses do not offer regular opportunities for cross-field cooperation outside joint courses with other departments or interdisciplinary classes for students from other departments. In addition, design professors typically have a background in the design field, which restricts their professional knowledge.

In conclusion, the aforementioned circumstances have created a predicament in current design education. However, according to the study results, the students believed that they performed well and improved their innovation ability, product strategy formulation, and design maturity. They were also able to master the operation of the design pattern. The experts also believed that the design achievements were excellent in all aspects. Specifically, the design pattern will both help enterprises in developing competitive innovative products and assist teachers in the design field in expanding the design vision of students to enterprise marketing; in this manner students are prepared to master the design standards of the industry after graduation. In addition, the study introduces a more comprehensive development orientation for design education. However, the focus of the study was improving student abilities in investigation, analysis, organization, and planning during the preliminary stage of design as well as the ability to draft design proposals that meet the needs of enterprises; thus, the design results were relatively insufficient in terms of product appearance and function details because of the limited time provided for the students to implement the design plan. The implementation duration of design plans may be extended in future studies, and a more profound exploration of functions, ergonomics, and aesthetic modeling may be conducted.

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