Presented at the 6th DLSU Innovation and Technology Fair 2018
De La Salle University, Manila, Philippines
November 22 & 23, 2018

DLSU Innovation and Technology Fair
Ideas and Solutions for Nation-building

Developing a New Product Design for an ID Case

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Abstract: This study focuses on the creation of a newly designed ID Case product which was formulated through the use of design process with the help of the tool House of Quality 1 & 2, concept selection and generalization, detailed design, and failure mode and effect analysis. The newly designed ID Case has a 10.5 x 5.7 x 0.3 cm dimension, having a weight of 0.1 kg. It is designed to have a triple track seal, SA/HA Nano-Film Coating, and no frame extrusion. The cost of this ID Case is Php 11.28.

Keywords: Design Characteristics; Design Process; House of Quality; Concept Selection; Concept Generalization

1. INTRODUCTION

An ID protector or ID case is used by students and employees across various professions to hold their ID so as to keep it safe and tidy. There are many different kinds of ID cases currently present in the market. Each of them have their own unique features to cater to the needs of different people. This paper will focus on a single variety of ID cases and that is the plastic ID case.

Numerous companies all over the world manufacture ID cases that are made from plastics. Each company's take on the design of an ID case targets different groups of customers through their preferences. Some ID cases are colored, while others are transparent. Some ID cases protect the ID completely from external factors, while others are vulnerable to external factors by having part of or the whole ID exposed. There is no standard design as it has been stated that all designs are different as some are minimalistic.

2. PROBLEM IDENTIFICATION

2.1 Needs Analysis

The current design of the ID Case seen in Figure 1. was observed and analyzed by the researchers. The Jelly Case ID Protector of Uniprint is designed to fit one standard ID card. The case has a weight of 0.1 kg and dimensions of 10.5 x 5.7 x 0.3 cm.

Figure 1. Jelly Case ID Protector

User observations are listed in Table 1. These were utilized for the construction of the survey questionnaire.

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Table 1. User Observations

Negative	Positive
Difficulty in removing their ID cards	Can be used for storing other things like small pieces of paper, keys, coins, bills, and other cards
Tends to get scratches while playing with it.	ID does not fall or slip off
ID case gets dirty easily	ID case does not break easily
The fingers of the students were stuck while pulling out the ID from the case	

To understand the needs of the customers and to evaluate the current product further, a survey was conducted. Product users were the respondents of this survey. This survey aims to capture the importance and satisfaction rating of the current product. Results from this survey will be utilized in the formulation of the planning matrix or the House of Quality 1. The sample size was calculated using the formula below.

$$\text{Sample size} = \frac{\frac{z^2 \times p\,(1-p)}{e^2}}{1 + \left(\frac{z^2 \times p\,(1-p)}{e^2 N}\right)}$$

Where: z = 1.96 on a 95% confidence interval
p = 80% of student population with Jelly ID case
e = 2.7182818285
N= total student population size

The survey was to be answered by 240 students as derived from the sample size formula below. The total population was estimated to be 9000 students in De La Salle University where 80% of the population (p) is estimated to possess the Jelly ID Case on a 95% confidence interval.

Table 2. Satisfaction with Current ID Case

Problems	Result (%)
Durability	80.4
Ease of Removing and Inserting ID	32.6
Aesthetics	41.3
Functionality	87.0
Overall Design	56.5

Table 3. Importance Rating of Product Characteristics

Product Characteristic	Importance Rating (%)
Price	78.2
Durability	100
Visually Pleasing	67.4
Water Resistivity	82.6
Cleanliness	93.5
Personalization	41.3

2.2 House of Quality 1

The House of Quality 1 shows the planning matrix wherein the customer and technical requirements of the product can be found. The matrix shows which problems or customer requirements should be prioritized based on the overall importance score. The overall importance score was calculated using the importance score from the survey, the sales point score of the requirements, and the target and current satisfaction scores.

Presented at the 6th DLSU Innovation and Technology Fair 2018
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November 22 & 23, 2018

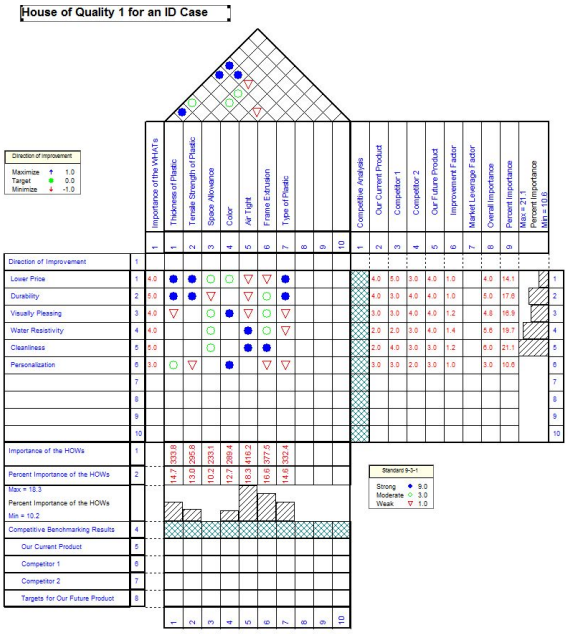

Figure 2. House of Quality 1 for ID case

Based on the results of the House of quality 1 of Jelly ID case of Uniprint which are shown above in Figure 2, The top 3 customer requirements to be addressed in this paper are (1) Cleanliness, (2) Water Resistivity, and (3) Durability.

2.3 Problem Statement

The Jelly ID Case by Uniprint exhibits problems with the cleanliness, water resistivity, and durability with a final weighted custer requirement percentage of 21.1%, 19.7%, and 17.5% respectively.

3. METHODOLOGY

3.1 Design Process

3.1.1. House of Quality 2

The House of Quality 2 was made in order to see the top 3 design characteristics are needed to help achieve the top 3 technical requirements found in the House of Quality 1. The top 3 technical requirements were found to be Air Tight, Frame Extrusion, and Thickness of Plastic. The design characteristics identified for the House of Quality 2 are Plastic Density, Temperature of Plastic During Cooling, Plastic Additives, Type of Opening, Frame Assembly, and Plastic Coatings. The top 3 identified design characteristics are Frame Assembly, Plastic Coatings, and Type of Opening.

3.1.2. Concept Generation

A concept generation tree was used to generate the various possible design solutions to improve the design of the current ID case. All product concepts will undergo initial pruning to eliminate infeasible solutions. The remaining concepts will then be used to construct the concept screening matrix. The concept screening matrix will then determine which solutions will be implemented in the final design of the ID case.

3.2 Detailed Design

After finalizing the components of the product, a computerized design of the proposed product was designed using the CATIA V5 software. The design was created by incorporating the new features on the current design of the ID case. This was done by physically measuring the dimensions of the ID case and adjusting the measurements of the ID case to fit the new features to be added.

3.3 Failure Mode and Effects Analysis

This would consider the various parts of the ID case and explore the possible modes of failure, which is defined as instances where the product fails to perform its intended use, and the overall effects of these on the overall experience when using the product.

3.4 Alpha Prototyping

The prototype design would be based on the detailed design after being subjected to a Failure modes and effect Analysis. The design dimension's thickness was also adjusted as printing the actual thickness would result in the prototype being too fragile to handle as the material used in the 3D printer does not have the same durability as the material used in the actual ID case. This is to avoid the prototype from breaking during handling. Other than the thickness being different, the prototype would function similarly to the designed product. The design was then converted to a physical form by the use of the 3D printing software, Unimaker. Additional functions that could not be printed using the 3D printer were installed by hand.

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4. RESULTS AND DISCUSSION

4.1 House of Quality 2

After considering the top three technical requirements from the House of Quality 1, the top 3 design characteristics were identified. Which are: Frame Assembly, Plastic Coatings, and Type of Opening. Using the Standard 1-3-9 scores, the relationship between the design characteristics and technical requirements were rated. Scores of 1 mean they have a weak correlation, 3 means there is a moderate correlation among the two, and 9 indicates that there is a strong correlation between the requirements and the characteristics.

4.2 Concept Generation

The first sub problem of the product is water resistivity. A brainstorming session was held in order to identify ways to address this sub problem. Plastic additives, Plastic Coatings, and Type of Opening were considered as nodes to address the problem after the session. However, since plastic additives and plastic coatings focus on the strength and appearance of the plastic material, it does not solve the water resistivity problem of the product. The type of opening was left and categorized into two nodes (1) air tight seal and (2) non-air tight seals. Some of these forms of seals have the capacity to prevent moisture and water from accumulating in the ID case. These seals are also known to be effective in waterproofing other ID cases.

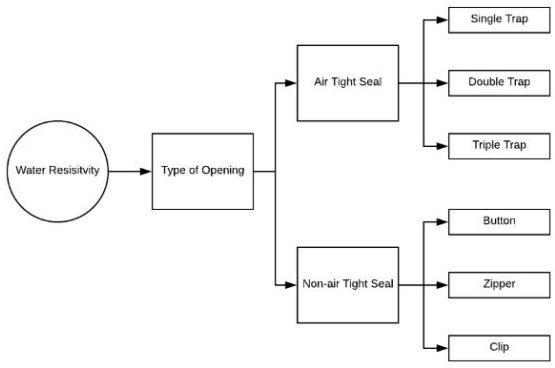

Figure 3. Concept Classification Tree for Water Resistivity

The second sub problem is the 'durability' of the ID case. The possible solutions for the sub problem was derived from another brainstorming session and these were split into 4 nodes, namely the plastic additives, plastic coating, curing temperature, and injection molding temperature. The plastic coatings branch was the only one left in the tree diagram because it best suits the issue of the ID case. The plastic coatings will be able to provide additional strength to the material. The plastic coating was also narrowed down to two possible examples, SA/HA Nano-Film Coating and Silicon coating, because it best suits the product.

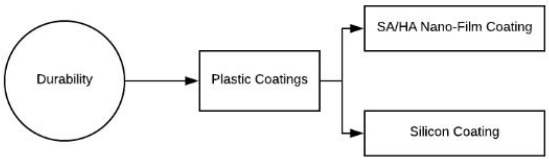

Figure 4. Concept Classification Tree for Durability

The last problem to be addressed was the cleanliness of the ID case. The sub problem was branched out into 3 nodes, namely Frame Extrusion, Plastic Coatings, and Type of Operating. To prevent possible errors in the final computation, Plastic Coatings and Type of Opening were pruned from the concept tree. Thus Frame Extrusion was the only viable way to solve the cleanliness of the ID.

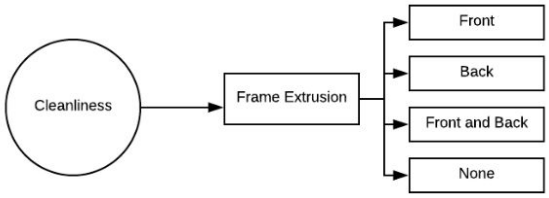

Figure 5. Concept Classification Tree for Cleanliness

4.3 Failure Modes and Effects Analysis

The different parts of the ID case were observed and analyze to determine the possible failures and risks. The parts in question were: The slot, ID slot, ID front face, and ID seal. The potential failure mode identified for the slot is the possibility of it ripping which could possibly lead the ID case to fall off. The ripping of the slot may be caused by the thin and small allowance surrounding the slot. There are two potential failure modes present in the ID slot. The first one would be the ID slot accumulates water inside. The second potential failure mode for this part is that the space for the ID slot is too tight. The tightness may damage the ID and erase the print on the ID card. The potential failure mode for the ID Front Face is that it accumulates dirt. This could

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make the ID less visible due to the dirt covering it. For the ID Seal, the potential failure mode is that the ID seal is not properly attached. The effect of this is that the seal will not close, which would allow dirt and moisture to accumulate in the ID case.

4.4 Prototyping

The design of the prototype was drawn using the CATIA V5 software. The model of the product was drawn such that it was scaled to the actual product with a ratio of 1:1 between the actual product and the prototype. The product was then printed in parts and assembled after 3D printing.

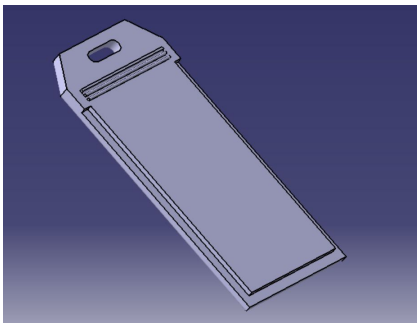

Figure 6. Front Half of ID Case

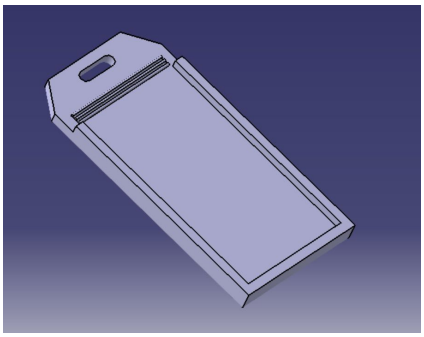

Figure 7. Rear Half of ID Case

4.5 Product Costing

Manufacturing cost and activity based costing was used to calculate and estimate the cost for the current ID case. It was assumed to be mass produced thereby reducing the cost. By producing 3200 units of the product, the breakdown of the manufacturing cost of the product can be seen in Table 4. The manufacturing cost is also divided into three parts namely, the direct material cost, direct labor cost, and direct labor hours.

Table 4. Activity Based Costing

Activity	Cost Measure	Total Units	Rate (Php)
Material Receiving	Kilos	290	30 / Kg
Production	Machine Hours	40	450 / Hour
Quality Control	Inspections	320	30 / Inspection
Packaging	Products	3200	0.5 / Product
Shipping	Deliveries	5	100 / Delivery

Material receiving pertains to the movement of the raw materials to be able to produce the product. This includes the minimum wage and the amount of time spent on moving the materials. The production was measured through the machine hours operating for 8 hours for 5 days. Quality control is done by doing a random sampling of 10% out of the total products produced. In this case, since there were 3200 products produced, 320 units were inspected. This costs about Php 30 per inspection by using quality control software. The material that was used for the packaging is a cheap plastic covering which only costs 50 cents per product for 3200 products. Delivery is divided into 5 batches, which costs Php 100 per batch, which happens 1 batch delivery per day. The total cost producing 3200 products is Php 45,125 allowing each ID case to cost Php 11.28. Which would allow the ID to be priced at 15 php to be able to accommodate a minimum of 20% profit.

5. CONCLUSIONS

A newly designed ID Case having the dimensions of 10.5 x 5.7 x 0.3 cm was done in order to address the voice of the customer with regards to the said product. There were different requirements and factors considered to be able to design the product. There were several procedures that the product development went through in order to fully maximize the resources and ideas to be able to create and address the customers needs. It was ensured that all

procedures and tools that were done for the product will be able to benefit the customers. After being able to generate the ideas and designs for the product, the prototype was created and tested through the use of failure mode and effect analysis tool. After the prototype was finalized, the overall costing was done and resulted to the ID Case amounting to Php 11. 28. The final design included a triple track seal, SA/HA Nano-Film Coating, and no frame extrusion.

6. REFERENCES

Bayus, B. (2007). Understanding customer needs. *Blackwell Handbook of Technology and Innovation Management. 1-49.*

Bouchereau, V., & Rowlands, H. (2000). Methods and techniques to help quality function deployment (QFD). Benchmarking: An International Journal, 7(1), 8-20. doi:10.1108/14635770010314891

Chan, L., & Wu, M. (2002). Quality Function Deployment: A Comprehensive Review of Its Concepts and Methods. Quality Engineering, 15(1), 23-35. doi:10.1081/qen-120006708

Cross, N. (1994). Engineering Design Methods - Strategies for Product Design.Chichester,UK: John Wiley & Sons.

Felix, E. (2015). Marketing challenges of satisfying customers changing expectations and preferences in a competitive market. *International Journal of Marketing Studies. 7*(5), 41-52

Franceschini, F. and Rossetto, S. (1995) QFD: the problem of comparing technical/engineering design requirements, Research in Engineering Design, Vol.7, pp. 270-278.

Gholizadeh, B. S., Buazar, F., Hosseini, S. M., & Mousavi, S. M. (2018). Enhanced antibacterial activity, mechanical and physical properties of alginate/hydroxyapatite bionanocomposite film. *International Journal of Biological Macromolecules, 116,* 786-792. doi:10.1016/j.ijbiomac.2018.05.104

Hendrick, C. (2005-04-14). *U.S. Patent No. US20050077348A1.* Washington, DC: U.S. Patent and Trademark Office.

Jiao, J., & Chen, C. (2006). Customer requirement management in product development: a review of research issues. Concurrent Engineering: Research and Applications. 14(3), 1-24

Kiran, D. R. (2017). *Total quality management: Key concepts and case studies*. Amsterdam:Butterworth-Heinemann is an imprit of Elsevier.

Liu, Y., Chakrabarti, A., & Bligh, T. (2003). Towards an "ideal" approach for concept generation. Design Studies, 24(4), 341-355.

Majava, K., Nutotiila, J., Haapasalo, H., & Law, K. (2014). Customer needs in market driven product development: Product management and r&d standpoints. *Technology and Investment, 5*, 16-25

Makhlouf, A. S., & Aliofkhazraei, M. (2016). *Handbook of materials failure analysis with case studies from the aerospace and automotive industries*. Oxford, UK: Butterworth-Heinemann, an imprint of Elsevier.

Mobley, R. K. (2002). *An introduction to predictive maintenance*. Woburn, MA: Butterworth-Heinemann.

Nouri, A., Yaraki, M. T., Ghorbanpour, M., Agarwal, S., & Gupta, V. K. (2018). Enhanced Antibacterial effect of chitosan film using Montmorillonite/CuO nanocomposite. International *Journal of Biological Macromolecules, 109*, 1219-1231.doi:10.1016/j.ijbiomac.2017.11.119

Okudan, G. E., & Tauhid, S. (2008). Concept selection methods - A literature review from 1980 to 2008. *International Journal of Design Engineering, 1*(3), 243-277. doi:10.1504/ijde.2008.023764

Osuna, M. M. (1998-07-13). *U.S. Patent No. US6226905B1.* Washington, DC: U.S. Patent and Trademark Office.

Pugh, S. (1991). Total design. Wokinham, England: Addison-Wesley Publishing Company.

Ratova, M., & Mills, A. (2015). Antibacterial titania-based photocatalytic extruded plastic films. *Journal of Photochemistry and Photobiology A: Chemistry, 299*, 159-165. doi:10.1016/j.jphotochem.2014.11.014

Soliman, H. (2011). Customer relationship management and its relationship to marketing performance. *International Journal of Business and Social Science. 2*(10), 166-182

Taura, Toshiharu (organization Of Advanced Science And Tech. (2016). *Creative design engineering - introduction to an interdisciplinary approach*. Elsevier Science Publishing.

Presented at the 6th DLSU Innovation and Technology Fair 2018
De La Salle University, Manila, Philippines
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Ulrich, K., & Eppinger, S. (2012). *Product design and development* (5th Ed). New York, NY: McGraw-Hill Companies, Inc.

Winterburg, C. S. (2012-06-26). *U.S. Patent No. US20130340901A1.* Washington, DC: U.S. Patent and Trademark Office.

Wypych, G. (2017). *Handbook of plasticizers*. Toronto: ChemTec Publishing.

Yan, C., Zhang, J., Han, J., Wang, X., Guan, Z., Zhang, L., . . . Shen, C. (2017). Improvement of environmental stress cracking resistance of polycarbonate by silicone coating. *Polymer Testing, 60*, 6-11. doi:10.1016/j.polymertesting.2016.11.007