

# Concurrent Design Strategy in Modeling and Structure of Trash can research

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**Abstract**—*For most people, making garbage is a common activity in life. As the number of garbage increases, the high cost, energy consumption and environmental pollution of subsequent processing will be something we cannot ignore. This article uses the theme of sorting garbage bins on campus to effectively recycle and reduce the amount of garbage. Firstly, through the user behavior observation, the problem status is clearly defined, the Objective tree analysis sets the design criteria and design specifications, and the Morphological chart method is used to carry out the modeling and detailing of the main components of the product. The design scheme is then introduced into the Analytic Hierarchical Process (AHP) and the Pugh concept selection to optimize the design. Research shows that this design program not only focuses on the innovation of appearance and function but also considers user needs and design quality to improve the feasibility of the product. After being deduced by this design process, the campus trash can presents different concepts and user experience from the past and has made breakthroughs in classification information, which not only improves the efficiency of campus garbage classification but also makes the surrounding environment tidier and meets effective design goals. It can be applied to the campus trash can design of this article, and it can be applied to other fields of design, and it is also very suitable.*

**Keywords**—*concurrent design, campus trash can, objective tree, morphological chart method, analytical hierarchy process, pugh method*

## I. INTRODUCTION

Along with life more convenient, Humans will create a lot of garbage every day. A lot of garbage is not recycled and disposed of freely, will cause environmental pollution. This article uses the campus trash can to do research. At present, the classified garbage bins are not clearly marked on the classified information, and the operation is inconvenient, therefore that most of the garbage is not effectively classified. This research is based on the Concurrent Design Strategy of campus trash cans, using a series of design methods to solve the problems of the current use of trash cans, and effectively carry out the product design and

the evaluation of the best design. This article focuses on making the current classified trash can easier to operate and clear classification information. Let people start from daily life to achieve the purpose of garbage reduction, and can create a beautiful and clean campus environment.[1]

## II. THEORETICAL BACKGROUND

### A. Objective Tree

The starting point for a design, demands and goals are ill-defined. Therefore, try to clarify the design objective is an important first step in designing. The objectives tree method offer a clear and useful format for such a statement of objectives. It's expanded list of design objectives and sub-objectives and grouped roughly into hierarchical levels[2]. There are three main steps:

- Step1: List all of the design goals.
- Step2: Order the list into hierarchical levels.
- Step3: Draw a diagrammatic tree of objectives, shown hierarchical relationship.

### B. Morphological chart method

The Morphological chart method provides a systematic and logical method to develop design concept efficiency. The chart sets out the complete range of elements and components, and hence to generate the complete range of alternative design solutions. There are four main steps:

1. Step1: List the features or functions that are essential to the product.
2. Step2: Find each feature or function and list the means by which it might be achieved.
3. Step3: Draw up a chart containing all the possible sub-solutions.
4. Step4: Identify feasible combinations of sub-solutions. [3]

### C. Analytical Hierarchy Process

The purpose of the development of hierarchical analysis is to systematize complex issues. Decomposing levels at different levels and using quantitative judgments to obtain a comprehensive assessment of the context can provide decision makers with the right choices and reduce the mistakes of decision-making[7].

The hierarchical analysis is a systematic process for solving hierarchical problems. It organizes problems after they have been dismantled layer by layer, allowing decision-makers to determine the order the weights of the problems through paired comparisons. [4][5][6]

D. Pugh method

After developing concept design, designer has to choose the best solutions among the alternative concepts. The Pugh’s method, called decision-matrix, is fairly simple and has proven effective for comparing alternative concepts. The method provides a means of scoring each alternative concept relative to another in its ability to meet criteria set by customers’ requirements. Comparison of the scores thus developed then gives insight to the best alternatives and useful information for making decisions. There are five main steps:

1. Step1: Choose the criteria for comparison.
2. Step2: Develop relative importance weigh factor.
3. Step3: Select the alternatives to be compared.
4. Step4: Evaluate alternatives.
5. Step5: Calculate the total score of each alternatives. [7]

III. CASE STUDY

A. Market Survey

Through the collection of various channel materials, the investigation and analysis will be carried out to obtain the main design objectives.

Investigate the various functional structures and design analysis of the existing public trash cans in the market, and clearly understand the main operational functions and secondary features of the continuous design, as shown in Table 1.[8]

TABLE 1 INVESTIGATE PUBLIC SPACE TRASH CAN

Place	Taiwan Railways Administration	Taiwan High Speed Rail	Park	School
Image				
Color	Silver	Silver/Black/Khaki	Silver/Blue/Red/Brown	Green /Blue/Gray/ Red
Size	43x33x88H cm	Φ40x90H cm	170x45x95Hcm	48x54x93H cm
Material	SUS 304 stainless steel	SUS 304 stainless steel	SUS 304 stainless steel	High density polyethylene
Advantages and disadvantages	<ul style="list-style-type: none"> <li>●Transparent design of the door panel to prevent danger</li> </ul>	<ul style="list-style-type: none"> <li>●Magnet side opening</li> <li>●Beveled design to avoid rubbish stacking</li> </ul>	<ul style="list-style-type: none"> <li>●Small hole to avoid large garbage thrown in</li> </ul>	<ul style="list-style-type: none"> <li>●Cover deodorization</li> <li>●Inconvenient to use</li> </ul>

The main goal of setting the product function at the beginning of the design is not only to grasp the core of the design, to realize it, but also to make the planning target not deviate. Recording the situation of garbage litter on campus, after observing and analyzing the user behavior, it shows that most people have a situation with unclear classification, which leads to the identification of garbage classification can only be seen in the trash can. As shown in figure1.[9][10]



Fig. 1. Observation of campus trash can

B. Problem analysis and design specifications

According to the above analysis, after setting the main problems of the campus trash can, the design requirements will be determined and divided into the following two items:

a) Demand : Necessary function

b) Wish : Non-essential function

Bring the demand/wish into the design and get the following Objective tree items, as shown in Figure 2.

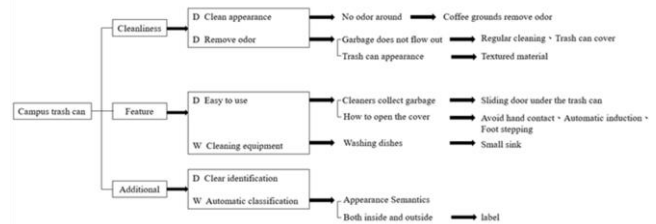


Fig. 2. Objective tree

The design goal of the design direction is determined by the Objective tree decision, but the specific details are not clear enough. Therefore, it is extended to define the policy and design specifications, so that the product design can have a clear standard or specification to follow the design. This article is designed with a campus trash can. In the case of meeting the functional requirements and the clean appearance, it is more important to consider the classification and labeling, so that the designed product is more suitable for people's needs.

C. Design process

In order to optimize the design, this study first analyzes

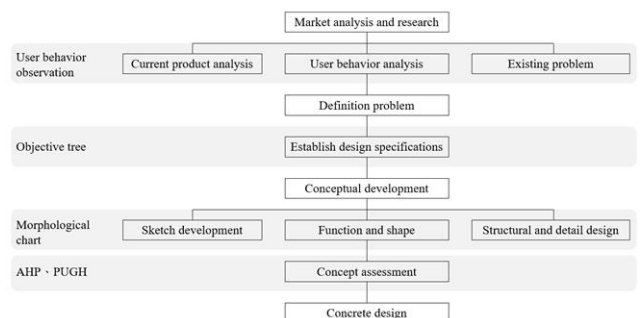


Fig. 3. Design process

the functional features of existing products. Use the Objective tree to determine the product's development direction, and cooperate with the Morphological chart method, AHP and PUGH to assist the campus trash can concept development and select the best design solution, this design process is shown in Figure 3.

**D. Concept develop**

The development of the overall shape uses the morphological chart method to develop the overall preliminary shape, as shown in Table 2.

TABLE 2. MORPHOLOGICAL CHART ANALYSIS OF EACH COMPONENT OF CAMPUS TRASH CAN

	1	2	3	4	5
A. Trash can cover	Square	Circle	Trapezoid	Triangle	Rounded Rectangle
B. Trash can	Square	Circle	Trapezoid	Triangle	Rounded Rectangle
C. Opening method	Foot switch	Hand pressure	Induction	dig a hole	
D How to mark classification	Classification icon	attach a label	Hole mark		
E How to collect garbage	Pick up the garbage bag	Trash can opening device	Garbage trill, smart notification		
F. Reduce odor	Near kitchen bucket	Trash can feel high quality	Dry cleaning hand device	Place coffee grounds	Full. Can't throw garbage
G. Multiple trash cans combined	separation a big trash can	Liter laced triangle trash can			

There are three variables to consider for overall shape development and structural development :

1. How the main function is configured on the structural variables.
2. How the product components are arranged in space.
3. Consider the size of the structural components and the size of each component space.

There are also three evaluation criteria for the development of the model :

1. Which of the space occupied by each component is the most reasonable.
2. Which of the following is the easiest to operate in the entire configuration.
3. Which of the products after the configuration is most coordinated.

Through the use of the morphological chart method, the development stage can achieve the divergence effect in a short time and propose various design schemes. This study takes the campus trash can as an example. By analyzing the elements of each part

of the shape, it diverges into a multi-design scheme, such as the following combination. As shown in figures 4 and 5.

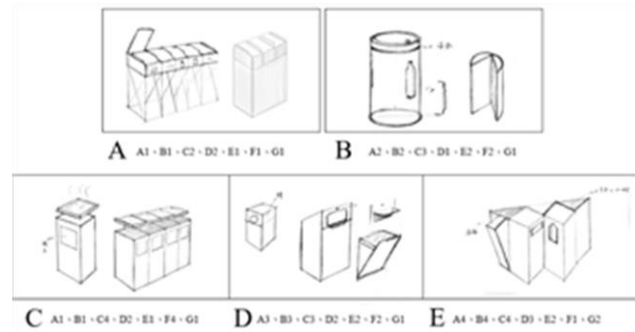


Fig. 4. Sketch development

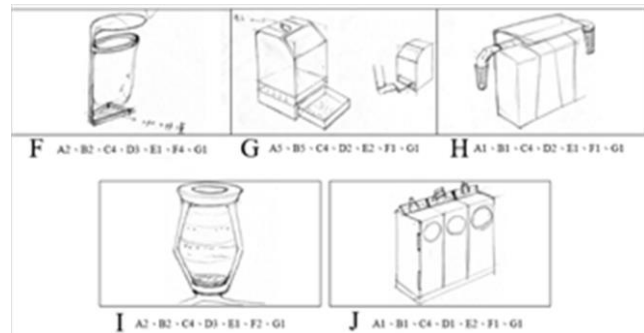


Fig. 5. Sketch development

**E. Concept assessment**

Product modeling needs to be subject to manufacturing possibilities before commercialization and mass production. Therefore, rationalization should be made when considering modeling integration, and then 10 sets of integrated concept plans are proposed, and then AHP level analysis method and PUGH are adopted. The concept selection program is used to evaluate the integration concept, refer to the design goals set by the objective tree, and set various parameters that may affect the quality of the product, such as physical function, appearance, ease of operation, manufacturing possibilities, component assembly, and Overall considerations such as the convenience of maintenance, summed up five evaluation specifications, as shown in Table 3.

After setting the evaluation criteria, the AHP level analysis method is used to find the weight ratio of the interaction between the various standards, the geometric mean of each column is calculated, and the geometric mean of each standard is normalized to generate weights ratio. In addition, the consistency check result was 0.071, which was less than 0.1, and was judged as valid data analysis, as shown in Table 4.

TABLE 3. FIVE EVALUATION SPECIFICATIONS

Is it convenient to open a trash can?	Is it easy for the user to use it?
Is the garbage classification label clear?	Is there any reduction in odor?
Is the appearance clean?	

TABLE 4. PUGH concept selection modeling development plan

	Xiaomi Tuo Niu	Program A	Program B	Program C	Program D	Program B	Program F	Program G	Program H	Program I	Program J	Weights
Easy way to open	D	-	S	+	S	+	+	+	+	+	+	0.272
Easy to use	A	+	-	-	+	+	+	-	S	-	+	0.422
Clear classification	T	+	+	+	+	+	+	+	+	-	+	0.158
Reduce odor generation	U	-	s	-	s	-	-	-	-	+	-	0.074
Clean appearance	M	-	s	-	s	+	-	-	-	-	-	0.074
Total		-1	0	-1	2	3	1	1	0	-1	1	
Weighted total		0.16	-0.264	-0.14	0.58	0.852	0.704	0.008	0.282	-0.308	0.704	

C.R.=0.071<0.1 Consistency check is judged as valid data analysis

The above 10 groups of ideas were screened by Pugh rational data to find the best design, as shown in Table 5.

+ This concept is better than DATUM ; - This concept is worse than DATUM ; S This concept is the same as incomparable with DATUM

After screening through PUGH, the best campus trash can design plan is E, and combined with the second high-scoring program F coffee slag element and program J trash can opening method meets the needs of Table 3, such as the substantive function, appearance, ease of operation, manufacturing possibilities and classification.

F. 3D Modeling

After generating the pattern according to the above evaluation, the 3D assembly is constructed and simulated, as shown in Figures 6 and 7.



Fig 6. 3D modeling combination chart



Fig 7. Campus trash can detail design

IV. RESULTS AND DISCUSSION

The design of the product is mainly based on the campus indoor trash can. The product design is different from the past, and the consideration is extended to the increasing amount of garbage in the society today, and

the high cost, energy consumption and environmental pollution of subsequent processing. This is the starting point to achieve effective recycling and reduce the amount of garbage. Its design features are:

1. The appearance has obvious classification marks to reduce the user's confusion about the classification of the trash can.
2. The classification is marked as a groove, and it can be a handle at the same time. It is convenient for the cleaning personnel to open the barrel and clean the garbage.
3. The lid is infrared-sensitive, and when it is close, it can automatically flip the lid to make people dump garbage.
4. Set up a small potted plant in front of the lid. You can choose to place the soil or coffee grounds so that the liquid left by the garbage can be poured to reduce the smell of the trash can.

The above characteristics are expected to solve the problem of garbage dumping on campus. In the past, the use of trash cans was inconvenient. Most people were reluctant to touch the trash can cover, resulting in unclear classification and unclear labeling. Later generations can only see the mistakes of their predecessors. The classification of littering, through this design to solve problems, while at the same time creating a good environment.

V. CONCLUSION

In the existing design projects, many processes are black boxed, lack of clear design specifications or design guidelines, often through the designer's perception and experience as the basis for product development, and this design process is unable to Analysis, improvement, and integration of various details make it impossible to achieve substantial improvement benefits. In this paper, through the concurrent design strategy, the design method and design evaluation are used to design the campus trash can, and the morphological chart, AHP, and PUGH concept selection methods are integrated into the development process of the trash can product design, and this way can not only meet the requirements. The user's actual functional expectation for this product can also meet the designer's requirements for the product and can complete the design solution to solve the existing problem with a more stable design policy.

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