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Application of Synchronous Design Strategy in Designing Travel Hair Dryers

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Abstract*—The hair dryer is an indispensable product for modern people, and it is available in every family. Because of the economic improvement and the improvement of the quality of life, in order to meet the needs of different users, many different functions or oriented hair dryer products have been derived. This article first investigates and analyzes the existing product market to understand the current public use and purchase of hair dryers. In the process, find the market position of the target group to determine the product, use the target tree method to find the problem direction and set the design target, and by Morphological chart method and Finite Structure Method (FSM) The combination, expansion and modeling of the main components of the product are developed. Several design schemes have been developed through screening. After the user's attention to the design goals, the Analytical Hierarchy Process (AHP) is used to select one or two solutions that are close to optimal optimization. In the process, sketches and computer-aided design, realize the design concept and open the black box of the design by several design methods. It is hoped that such a process can improve the shortage of existing products and satisfy consumers.

Keywords*—Synchronous design, hair dryer, Morphological Analysis, Finite Structure Method, Analytic Hierarchy Process

I. INTRODUCTION

In a report of the China Industrial Research Institute[1], as the most common hairdressing appliances, the popularity of hair dryer products in Chinese consumers and hotels is high. With the improvement of consumers' quality of life and the increasing emphasis on personal image instruments, the use of hair dryers continues to expand, and the penetration rate of male consumers has also increased significantly. At the same time, the pursuit of fashion characteristics by female consumers has led to the replacement of products. Maintaining a high level further promotes the expansion of the hair dryer market. In 2014, the retail sales of the hair dryer market were 1.24 billion CNY. It is expected that after 2015, with the gradual recovery of the hair dryer market and the expansion of demand from product upgrades, the market will gradually stabilize and recover. It is estimated that by 2022, the hair dryer market will grow to 1.79 billion CNY shown in Figure 1.

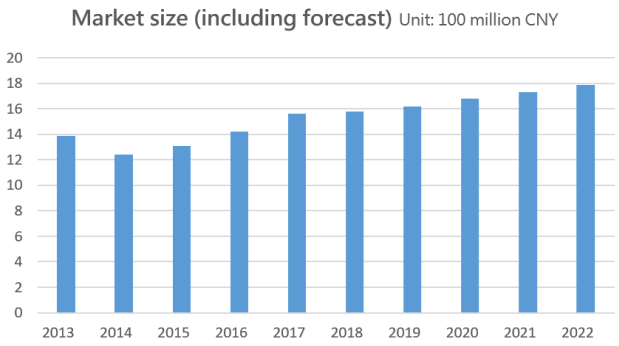

Fig. 1. China hair dryer market

II. THEORETICAL BACKGROUND

A. *Finite Structure Method (FSM)*

The Finite Structure Method (FSM) first establishes the main function of the product, and then decomposes the secondary function from the main function. The secondary functions are changed in a certain amount such as configuration, arrangement of space, and size to obtain the desired shape. In order to achieve the main function of the purpose of the allocation of secondary functions, and then produce product modeling, the following steps are carried out[2].

Step1: Identify all the main function of the target product.

Step2: Decompose the main function which is the combination of several sub-functions, and limited with a certain number elements.

Step3: Quantify the basic structure, which is the arrangements of limited sub-functions.

Step4: Ensure the form of multiplicity, we consider the consistency of the original product design.

Step5: Choose the best alternative. The main function of the product is divided into a combination of several secondary functions, and the elements that

achieve the secondary function are referred as components. The combination of components also changes the shape of the product, so each product can use this concept to reorganize the sub-functional components and assist in the development of the design.

TABLE 1 EXISTING PRODUCT SURVEY

Type	Basic type	EH-NA98	Mouster	Recovery	Supersonic	TCD4000
Brand	PHILIPS	Panasonic	KOIZUMI	LOUVERDO	Dyson	Tescom
Price (TWD)	500-2000	6000	2600	4500	15000	3000
Features	1500W、Two-stage wind speed、Three-stage temperature	1200W、Three-stage wind speed、Four-stage temperature	1400W、Four-stage (turbo、hot、cold)and weak)	750W(Far Infrared)、Two-stag wind speed	1600W、Three-stage wind speed、Four-stage temperature	1200W、Three-stage wind speed、Three-stage temperature
Accessories	Standard nozzle	Built-in nozzle、Molding nozzle	Standard nozzle	Standard nozzle	Standard nozzle、Wind blow nozzle、diffuser hair dryer	Standard nozzle
Structure	Traditional structure	Traditional structure	Traditional structure	Traditional structure	Traditional structure (Motor position change)	Traditional structure
Advantage	Instant cold wind	Nanoe-Nano water ion、Four-stage constant temperature	2.0m^3Large amount of wind、Touch button adjustment	Negative ion、Far infrared、Low temperature drying	Maximum air output、constant temperature、Negative ion	Nano water mist、Collagen、Negative ion
Picture						

B. *Morphological chart method*

Morphological chart method include various parameters and components that describe the functional characteristics needed to produce a product. They point out the appearance and connotation of product; components are the characteristics that can be described in parameters or the means or methods that can be implemented[3]. All in all, it is a form design method that dismantles the original product into various design elements by dismantling and regroups these design elements[4][5].

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[6]. 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[7] [8] [9].

III. CASE STUDY

As one of the most common household appliances, with the improvement of consumers' quality of life and the increasing attention of personal image, the use of hair dryers continues to expand, and the popularity of male consumers has also increased significantly. At the same time, female consumers pursue fashion. The characteristics have kept the frequency of product replacement at a high level, further contributing to the expansion of the hair dryer market. The hairdryer market, from the previous single basic functions to the current manufacturers to add functions on the hair dryer, so that there are many hair dryers with unique functional appeals in the market, jumping away from the highly homogenized hair dryer market... And select some products among many products to do the existing product survey analysis chart and the image scale analysis chart of the existing products shown in Table I. and Figure 2.

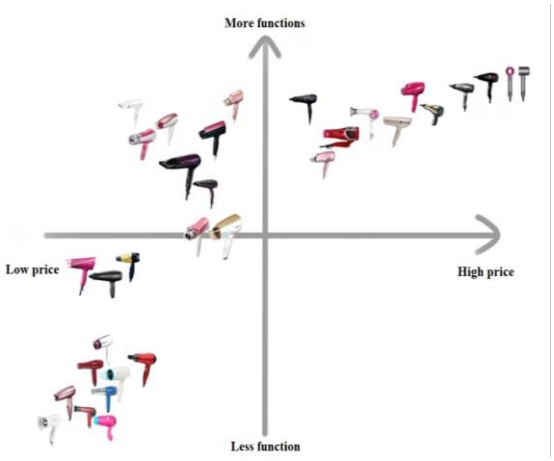

Fig. 2. Image scale

- The meaning of horizontal axis coordinates is: Low price → High price
- The meaning of vertical axis coordinates is: Less function → More function

According to the product of the image scale position, the difference of the existing product can be understood. During the process, the integrity of the retained image is used as a reference for subsequent design, and the image scale analysis is used as a model. On the image scale, Low price and High price are the horizontal axes of the coordinates, and the Less function and More function are the vertical axes of the coordinate axes are shown in Figure 2.

This article sets the target group of this product as a business traveler. This target group has the need for regular business trips. Because of the quality of life requirements, the hair dryers provided by hotels is not good enough to meet their requirements for blowing hair. So need a product that meets their needs and is easy to carry. After interviewing a number of respondents who are close to the target group, they are office workers between the ages of 20 and 40. During the year, they need to travel more than twice for a business trip. Through simple interviews, to understand the need functional requirements for the portable hair dryer. In the process of interviews, understand the problems they care about. They hope to focus on the integrity and perfection of basic functions, and convenient to carry is also what they expect because if it is not easy to carry, they can use the hairdryer provided by the hotel directly. For the appearance, the unique and not losing attractive is what they want, and the function of voltage conversion is a must-have function. For those who often travel to different countries, this is their carrying hair dryer. So this is the most needed feature[10].

A. Black box analysis

In the use of the hair dryer, there will be many practical steps. Through analyzing the procedure hidden between the input and output of the hairdryer with a black box analysis, and predict the potential problems and difficulties in using, and each link to design thinking as Figure 3.

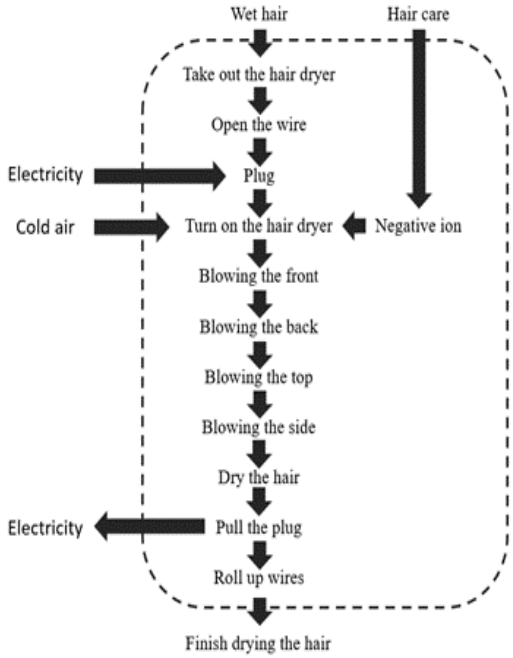

Fig. 3. Black box analysis

B. Target tree

According to the analysis set, the parts of the product and design requirements brought into the design projects. Use this information to draw the target tree of this design as Figure 4.

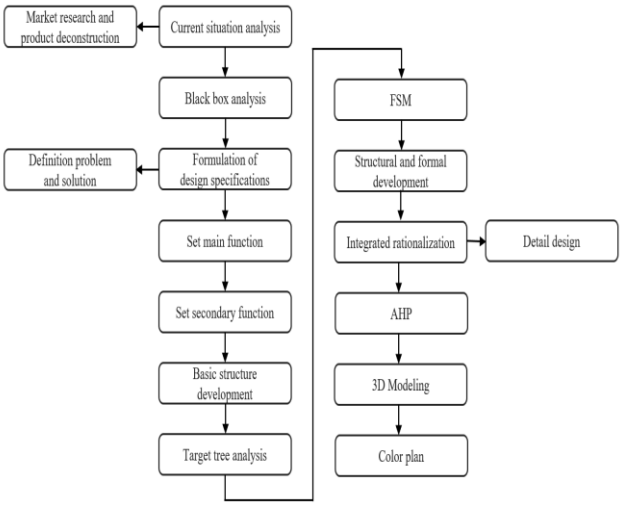

Fig. 4. Target tree

C. Design process

Optimize the design by analyzing the features and characteristics of existing products. Use the image scale to determine the product's development direction. Cooperate with the Morphological chart method, FSM, and AHP to the development and select the best design solution for hair dryer concept. This design process is shown in Figure 5.

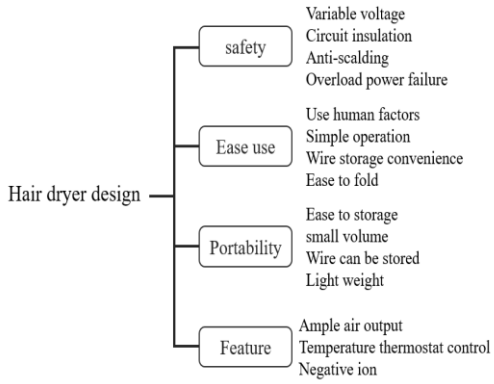

Fig. 5. Design process

D. Concept develope

Use the image scale to determine the product's development direction. Cooperate with the Morphological chart method, FSM, and AHP to the development and The development of the hair dryer in this article is divided into three phases. The detailed steps are as follows:

1. Morphological chart method: The concept of hair dryer re-design is introduced according to the Morphological chart method, as shown in Table II.
2. To facilitate the development of subsequent concepts, The parts of the hair dryer are simply divided into four units through the following Figure 6, which are respectively a heating unit, an inlet and outlet unit, a holding unit, and a wiring unit.
3. Figure 7 below shows the possible structural layout of the hair dryer using the Finite Structure Method (FSM)

TABLE 2. Morphological chart

		1	2	3	4	5
A	Nozzle					
B	Handle					
C	Inlet					
D	Host					

Fig. 6. Divided into four units

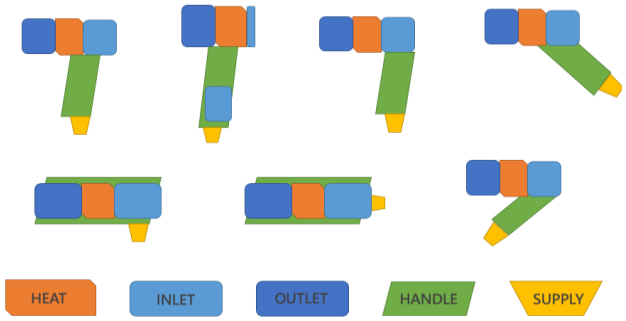

Fig. 7. Finite Structure Method (FSM)

4. Develop several possible combinations through Morphological chart
   - Plan A (A5+B1+C3+D2) → Figure 8(A).
   - Plan B (A5+B3+C3+D2) → Figure 8(B).
   - Plan C (A2+B3+C3+D5) → Figure 8(C).
   - Plan D (A5+B1+C4+D2) → Figure 8(D)
   - Plan E (A5+B4+C3+D4) → Figure 8(E).

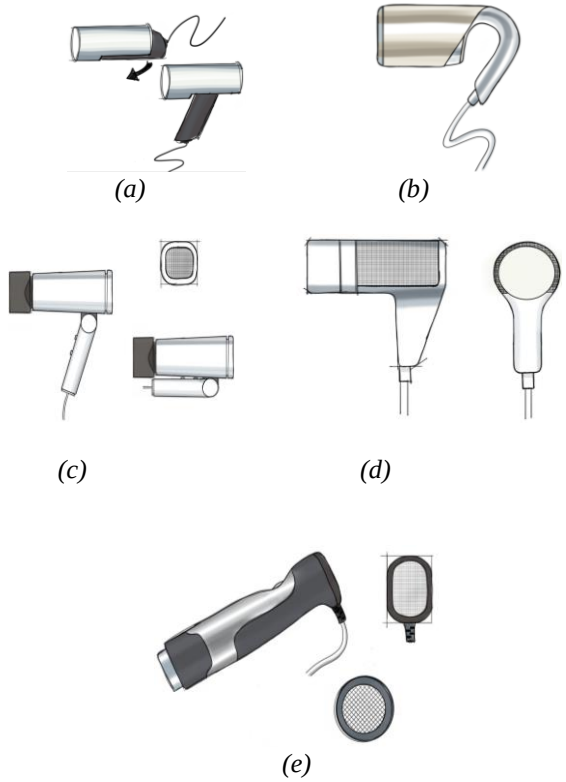

Fig. 8. Concept sketch

E. Concept assessment

The design draft was compared with Dyson supersonic and Panasonic NA98 through the Analytical Hierarchy Process (AHP). The six items compared were portable, wire storage, operation, air volume, human factor design, and price. I hope to pick the best solution through AHP. Use the AHP method to calculate the best plan and use Tables 4-9 as the selection criteria, and base on AHP analysis and weight addition calculation, the weight values are shown in Table 3. Finally, the AHP matrix operation is performed on the design scheme. The operation result is shown in Equation (1).

F. 3D Modeling

Through the above AHP method to evaluate the A to E five programs, the final calculation result is that the best design for the A, the A program to 3D software construction product appearance shown in Figure 9(a to f).

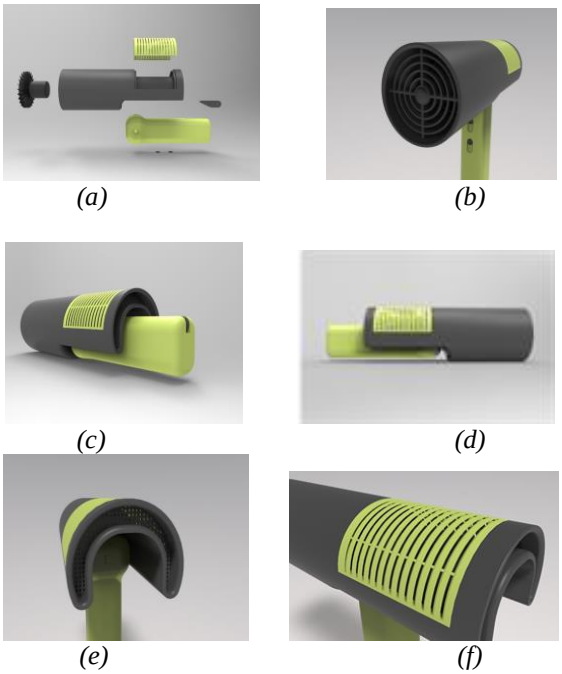

Fig. 9. 3D model

(A) Explosion drawing (B) Expanded seen from the front (C) Folded seen from the rear (D) Folded seen from the rear (E) Expanded seen from the rear (F) Folded seen from the top (G) Expanded seen from the top

G. Color planning

Use PANTONE SOLID UNCOATED's popular pop colors (Figure 10) to pick six colors as a dark gray black color scheme to make a color planning for the design, as shown in Figures 11-12.

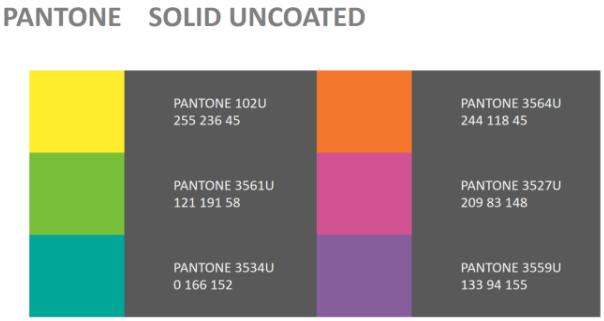

Fig. 10. Pantone solid uncoated

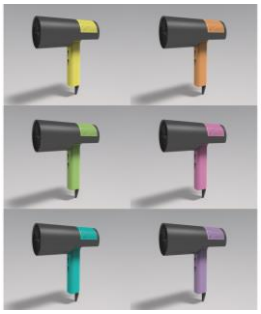

Fig. 11. Color matching simulation

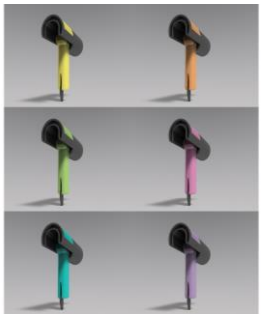

Fig. 12, Color matching simulation

IV. Discussion and Conclusion

In the past, the design has made people think that they are designing and developing products based on the designer's point of view, ideas, aesthetics, and experience. This often leads to doubts about the design process, because there is no objective sentence that can support the designer's ideas. Some people think that the success of the product is like accumulating luck or experience. In the process of design, there is no way to clearly present the design process, or there may be a lack of design deviation from the design goal. Can not effectively solve the problem and make the product fail.

In this article, through the synchronization strategy design, using a variety of design and analysis methods, such as Morphological chart, FSM, AHP and other methods applied to the hair dryer design, not only meet the user's substantive needs but also meet the aesthetics. At the same time, it can meet the designer's expectations of the product itself, but also accelerate the design process and the accuracy of the design for the target.

TABLE III. Weight values

	Portable	Wire storage	Operation	Air volume	Human factor	Price	Geometric average	Weights
Portable	1	3	3	3	5	5	2.96176522	0.40813749
Wire storage	1/3	1	1	1	3	3	1.20093696	0.16549164
Operation	1/3	1	1	1	3	3	1.20093696	0.16549164
Air volume	1/3	1	1	1	1	1	0.83268318	0.1147455
Human factor	1/5	1/3	1/3	1	1	1	0.53023035	0.07306686
Price	1/5	1/3	1/3	1	1	1	0.53023035	0.07306686
Total							7.256783	1

TABLE IV. Portable

Portable	Dyson Supersonic	Panasonic nanoe NA9S	Plan A	Plan B	Plan C	Plan D	Plan E	Geometric average	Weights
Dyson Supersonic	1	3	1	1	1/3	1	1/3	0.85475	0.10381
Panasonic nanoe XA98	1/3	1	1/3	1	1/3	1/3	1/5	0.42414	0.05151
Plan A	1	3	1	3	3	3	1	1.87344	0.22753
Plan B	1	1	1/3	1	1/3	1	1/3	0.6244$	0,07584
Plan C	3	3	1/3	3	1	3	1/3	1.36874	0.16623
Plan D	I	3	1/3	1	1/3	1	1/3	0.7306	0.08873
Plan E	3	5	1	3	3	3	1	2.35773	0.28634
Total								8.23388	1

TABLE V. Wire storage

Wire storage	Dyson Supersonic	Panasonic nanoe	Plan A	Plan B	Plan C	Plan D	Plan E	Geometric average	Weights
Dyson Supersonic	1	1	1/3	3	1	1	1	1	0.12196
Panasonic nanoe XA9S	1	l	1/3	3	1	1	1	1	0.12196
Plan A	3	3	1	5	3	3	3	2.75838	0.33642
Plan B	1/3	1/3	1/5	1	1/3	1/3	1/3	0.36253	0.04422
Plan C	1	1	1/3	3	1	1	1/3	0.85475	0.10425
Plan D	1	1	1/3	3	1	1	1/3	0.85475	0.10425
Plan E	1	1	1/3	3	3	3	1	1.36874	0.16694
Total								8.19915	1

TABLE VI. Operation

Operation	Dyson Supersonic	Panasonic nanoe XA9S	Plan A	Plan B	Plan C	Plan D	Plan E	Geometric average	Weights
Dyson Supersonic	1	1	1	3	1	1	1	1.16993	0.15789
Panasonic nanoe XA98	1	I	1	3	1	1	I	1.16993	0.15789
Plan A	1	t	1	3	1	1	1	1.16993	015789
Plan B	1/3	1/3	1/3	1	1/3	1/3	13	0.38998	0.05263
Plan C	1	1	1	3	1	1	1	1.16993	0.15789
Plan D	1	1	1	3	1	1	1	1.16993	0.15789
Plan E	1	1	1	3	1	1	1	1.16993	015789
total								7.40956	1

TABLE VII. Air volume

Air volume	Dyson Supersonic	Panasonic nanoe XA98	Plan A	Plan B	Plan C	Plan D	Plan E	Geometric average	Weights
Dyson Supersonic	1	3	3	3	3	1	3	2.19IS	0.2708
Panasonic nanoe XA98	1/3	1	1	1	1	1/3	1	0.7306	0.09027
Plan A	1/3	1	t	1	1/3	1/3	1	0.62448	0.07716
Plan B	1/3	l	1	1	1	1/3	1	0.7306	0.09027
Plan C	1/3	1	3	1	1	13	3	1	0.12355
Plan D	1	3	3	3	3	1	3	2.1918	0.2708
Plan E	1/3	1	I	1	1/3	1/3	1	0.62448	0.07716
Total								$.09376	1

TABLE VIII. Human factor

Human factor	Dyson Supersonic	Panasonic nanoe XA98	Plan A	Plan B	Plan C	Plan D	Plan E	Geometric average	Weights
Dyson Supersonic	1	3	1	5	1	1	3	1.72256	0.21862
Panasonic nanoe X A98	1/3	1	1	3	1	1	3	1.16993	0.14849
Plan A	1	1	1	3	1	1	3	1.36874	0.17372
Plan B	1/5	1/3	1/3	1	1/3	1/3	1	0.42414	0.05383
Plan C	1	1	1	3	1	1	3	1.36874	0.17372
Plan D	1	1	1	3	1	1	3	1.36874	0.17372
Plan E	1/3	1/3	1/3	1	1/3	1/3	1	0.45625	0.05791
Total								7.S7908	1

TABLE IX. Price

Price	Dyson Supersonic	Panasonic nanoe NA98	Plan A	Plan B	Plan C	Plan D	Plan E	Geometric average	Weights
Dyson Supersonic	1	1/3	1/3	1/3	1/5	1/5	1/5	0.3133	0.03664
Panasonic nauoc NA98	3	1	1	1	1/3	1/3	1/3	0.7306	0.08544
Plan A	3	1	1	1	1/3	1/3	1/3	0.7306	0.08544
Plan B	3	1	1	1	1/3	1/3	1/3	0.7306	0.08544
Plan C	5	3	3	3	1	1	1	2.01527	0.23568
Plan D	5	3	3	3	1	1	1	2.01527	0.23568
Plan E	5	3	3	3	1	1	1	2.01527	0.23568
Total								8.55091	1

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