

Design of Eco-Friendly Pen Made Of Coconut Shell Waste

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Abstract. Coconut is one type of versatile plant whose entire tree has many benefits for humans, from the roots, leaves, and fruit. Coconut shell is an endocarp of coconut fruit is a waste from coconut. Besides being used as a variety of household and handicrafts, it can also be used as a material for making pens. This study aims to determine the best design of coconut shell pens. The stages of product design as follows: identification of needs, problem analysis, project planning, product concept planning, product design, preparation of documents in the form of product images designed, and product manufacturing specifications. After product evaluation design has the highest score is obtained. So, the chosen concept will be further developed to become a pen that can compete in the market. The design result is a pen with circle-shaped aluminum body, dimensions 8 x 125 mm, using an ink tube with gel, removable front cover, end cover can be rotated and grip using a coconut shell.

Keywords: **Design; Concept; Pen; Coconut Shell.**

1 Introduction

Product design and development are all processes that are related to the existence of products that cover all activities ranging from identifying consumer desires to fabrication, sales so delivery of products [1]. The design and development of this product is a part of the abstract that exists in the business world. Coconut is fresh fruit and is useful for helping fluids in the body. Coconut is one type of versatile plant and has a high economic value. All parts of the tree have many benefits for humans from the roots to the leaves and of course the fruit. Coconut trees have a million benefits, besides being eaten coconut meat dried as a raw material for making coconut oil (copra) and by-products from the copra industry are coconut shells which are rarely processed further. Coconut shells or shells which are actually endocarp of coconut fruit are waste from coconut, often used as fuel, substitute for dipper, beverage containers, and raw materials for various forms of handicraft. Besides making different types of household and crafts, shells can also be used as a material for making pens because they have a unique texture.

Pens are writing equipment which has a form of sharp-pointed that are equipped with rods and a grip containing a refillable ink tube [2]. Scratches when the use of pens on written media is often called handwriting. Handwriting in most languages is the result of two main movements, one horizontal from the movement of the wrist and one vertical from the movement of the fingers with, the addition of the correct translation of the entire

arm [3, 4]. Handwriting results are mainly based on touch, taste, aesthetics and muscle activity [5].

In this design, the author tries to use a coconut shell as a raw material for making pen products. Coconut shell processing followed by the selection of a right coconut shell type, then it is selected to be shaped 8mm diameter ring with a 4mm hole. The ring is then polished to achieve N6 smoothness until it can be assembled and made into a pen grip. Pen design always experiences developments starting from the shape and function. Initially, pens and ink were used separately. The pen was initially made of goose feather as is commonly used in medieval Europe, and the reed stems used in the Middle East or even brushes used in China and Japan. The disadvantage is that its use often troubles the wearer because the ink spilled or also spilled on paper so that in 1938 the Ballpoint Pen was created by a Hungarian journalist named Laszlo Biro. Bold point is writing equipment whose edges use small balls in the form of brass, or tungsten rotates to control the release of ink stored in a cylindrical tube [6]. Based on these conditions the pen cannot be directly used without the pen body so in this study the body made of Aluminum, using a ball point type gel ink pen / 0.4 mm with coconut shell grip material.

Pens with a diameter of 7.9 mm are the most suitable for kindergarten school students [7]. In another study found that the quality of the writing depends on the diameter of the pen, not only the length. 8 mm diameter is the best suited for stylus pens with identical ink inserts with a size of 0.5 mm used in each pen [8]. This is closely related to the function of the pen is handheld

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manually. 'Dynamic Tripot' is one of the most common ways to hold writing equipment [9], this is where the thumb, index finger and middle finger hold the pen so that they function together in their research to find that such grip requires good motor coordination [10].

In the writing process, if the pen is held between the index finger and middle finger with a more sloping wrist, the muscles are more relaxed so that the writing comfort is more optimal [11]. In addition to how to hold the body, the pen rod is a factor that increases quality and effect when writing. The emphasis is given on grip surface also affects. This has been extensively investigated with different strength variations [12]. Therefore this design is focused on evaluating the cross-section of the pen (shape, size and, mass).

The limitation of the design problem of the pen that was designed was 8 mm in diameter with consideration in the previous study using three cross-sectional forms including circle, hexagonal and elliptical. Although in the previous study no significant differences were found between the cross-sectional forms [13].

This study aimed to determine the design of the optimal pen shape, with the hypothesis that the cross-section design of the pen affected the writing ability and comfort of writing.

2 Methods

The design process is expected to transform needs that are not defined as quality products. A lot of literature that has tried to describe the design and resolution of the design itself. Design is an activity or engineering that starts from the ideas of innovation to product works and inventions that really can describe market demand because of technology research and development [14].

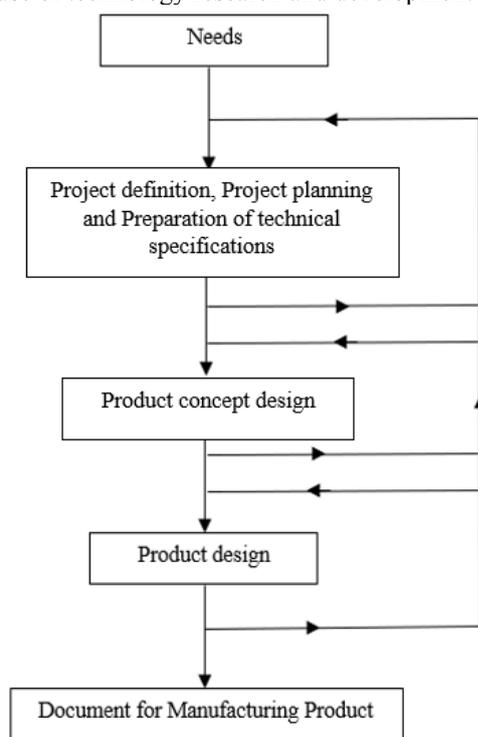


Fig.1. Design stage

The design consists of a series of sequential activities because the design is then referred to as the design process which includes all activities contained in the design. Decision-making methods, also known as the push method, are activities in the design process called phases. The phases in the design process differ from one another. Each stage itself has several events, called steps in phase. One description that states that in the design process consists of the following aspects: (1) Identification of needs, (2) Definition of projects, problem analysis, preparation of product technical specifications, and project planning, (3) Product concept planning, (4) Product design, (5) Preparation of documents in the form of product drawings as a result of product design and manufacturing specifications [15]. The phase can be illustrated in Figure 1 the flow diagram as we can see above.

2.1 Identification of Needs

Based on the flow diagram Figure1 the next design stage is needs identification aims to make accurate product manufacturing specifications for the design of a product's design, in designing the designer the boundaries of the target are to be achieved, but these limits should not be too narrow, because specifications that are too broad will lead to improper solutions [16]. Identifying customer needs starts from listing customer needs about pens that have a level of comfort in writing. The next step is to determine consumer needs for the product design that has been designed. Using a table of need determination, the product specifications desired by consumers will be obtained. Wish is a design of a designer that matches the needs of consumers, while Demand is a consumer demand that is not following the results of the design. The following is a Table 1 for determining the following causes.

Table 1. Determination of needs

NO	D/W	TERM
1	W	The shape of the pen rod is made a circle
2	W	The pen's length is 125 mm
3	W	8 mm pin diameter
4	W	The color of the pen is silver
5	D	Complete, correct pen
6	W	Grip the pen using waste material
7	W	Pen durability of 3 years
8	D	Engraved pen pattern

2.2 Project Planning and Engineering Specifications

The project design, the most essential thing is to determine the objectives of the product design that will be made. The method used is the goal tree (Objectives Trees), then we can identify the goals and sub-objectives of the design of a product in the form of a diagram that shows a parallel relationship between the objectives and sub-objectives. The steps taken are as follows:

1. Make a list of design goals.

2. List structure in the order of goals from higher-level to lower-level.
3. Draw a destination tree diagram, to show a parallel relationship.

The design of this product is the result of a brainstorm between the writer and the team, created a tree diagram as follows:

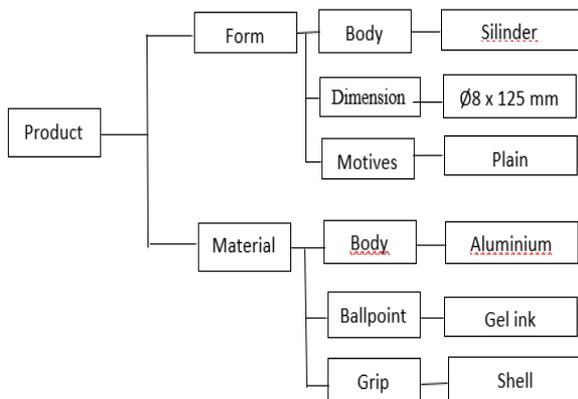


Fig.2. Destination tree diagram.

The next stage of the product concept was developed into the design of the product with the 'black-block' approach developed an input to output to realize the product, then the function of the product made from coconut shell pens as seen in the following figure.

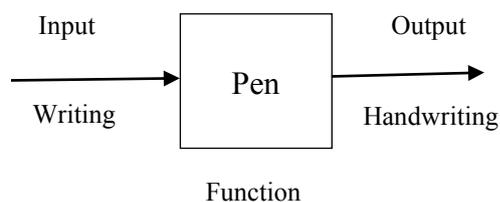


Fig.3. Function assignment diagram.

From Figure3 the analysis of functions we can conclude that the role of the pen can be described as a function block with incoming and outgoing flows. In the pen to be designed When the inflow is in the form of writing activities carried out by hand then the flow of information is converted into handwriting.

2.3 Product Concept Design

In the product design concept is to make several fountain concepts from a combination of function concepts using morphological methods, then evaluate the concept to get a selected concept. The steps taken are a decomposition of functions, the conceptualization of each task, incorporation of concepts and evaluation of concepts.

The design concept is limited to pen parts such as cross sections: circle, hexagonal and elliptical. As in the picture Figure 4 below.

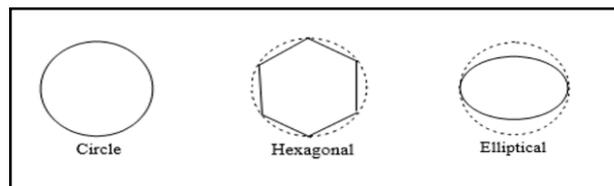


Fig.4. Body Pen.

The product design concept is limited to pen parts only by using the morphology matrix to determine concepts based on consideration of pen part selection, there are 5 parts that are used as references in choosing concepts include: (1) body (2) ink tube (3) front cover (4) end cover (5) grip. In the morphology matrix as in the table. 2 will compile several concepts that may be made.

Table 2. Matrik morphology

NO	PART	A	B	C
1	Body	Circle	Hexagon	Elliptical
2	Ink Tube	Gel	Refill	
3	Front Cover	Removable	Non-Removable	
4	End cover	Rotate	Trigger	Rigid
5	Grip	Coconut shell	Rubber	Knurling

The product concept has been obtained from the morphology above, there are 3 concepts that meet the standards, with consideration may or may not be made. The concept will be made in the form of sketches in the hope that the images can be analyzed to be the best concept. This will be developed in the product manufacturing process in terms of technology and cost aspects. The concept is

Concept 1: 1A - 2A - 3A - 4A - 5A. This concept is from parts: Circular body shaped circle, Ink tube with Gel, the front cover can be removed, end cover can be rotated and grip using coconut shell.

Concept 2: 1B - 2A - 3A - 4A - 5A. This concept of parts: Hexagonal shaped body cross-section, Ink tube with Gel, removable front cover, end cover can be rotated and grip using coconut shell.

Concept 3: 1C - 2A - 3A - 4A - 5A. This concept is from parts: elliptical shaped body cross-section, Ink tube with Gel, removable front cover, end cover can be rotated and grip using coconut shell.

After getting a combination of concepts, one of the concepts was evaluated by going / no-go screening using technology assessment. At this stage, the evaluation is carried out to fulfill the customer's request aimed at the three selected concepts above with two "Go" or No-go answers. Each concept will only have two answers, namely "yes" (Go) or "no" (no-go). The concept that answers the most "Go" is the chosen concept. The following is the application:

Table 3. Go or no go screening

No	Customer's request	Concept 1		Concept 2		Concept 3	
		Go	No-go	Go	No-go	Go	No-go
1	Strong	√		√		√	
2	Durable	√		√		√	
3	Comfortable	√			√		√
4	Cheap	√		√		√	
5	Interesting	√			√		√
6	Light	√		√		√	
7	Mass product	√		√		√	
8	Refillable	√		√		√	

From the above evaluation one concept was chosen as follows: Concept 1: 1A - 2A - 3A - 4A - 5A namely circle body cross-section, Ink tube with Gel, removable front cover, end cover can be rotated and grip using coconut shell.

3 Result

3.1 Product Design

After the product concept design phase, the product design in the form of a concept that is still in the way of sketches will be given shape. From the selection of concepts, concept one has been chosen which will then be formed into a pen. Product design is done based on the flow diagram of the design stage. After the concept design stage uses the morphology method, the three selected concepts are evaluated by giving weight to each concept using the decision-making matrix. As for determining the desired design criteria, namely

1. Strong and durable.
2. Comfort writing.
3. Ability to write.
4. Prices are relatively cheap.
5. Easy production process.
6. Can be in mass products.

Table 4: Basic Decision Matrix

No	Section Criteria	Weight	Design			
			1	2	3	4
1	Strong and durable	8	+	+	+	+
2	Comfort writing	10	+	+	-	-
3	Writing Ability	10	+	+	-	-
4	Prices are relatively cheap	11	-	-	+	+
5	Easy production proces	8	+	+	+	+
6	Cane be in mass products	7	+	-	-	+
Total +			5	4	3	4

Total -	1	2	3	2
Total Value	43	36	27	34

From Table 4 the basic decision matrix, the product concept that has the highest score is obtained, namely the first product concept (cross-body shape in the circle, Ink tube with Gel, removable front cover, end cover can be rotated and grip using coconut shell). Then this concept that will be developed is then the basis for designing and utilizing coconut shell. The following shows the solid modeling of the products to be developed, this modeling is done using the Autodesk Inventor 2017 software.

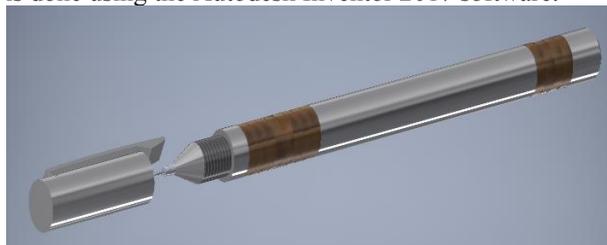


Fig. 5. Model assembly pen

3.2 Product Manufacturing Document

After the process of giving the form, it is necessary to make a technical document for the manufacture and need for the production process.

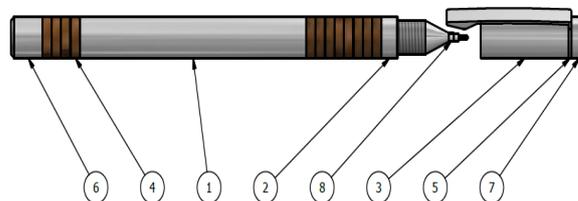


Fig. 6. Assembly pen

4 Conclusion

From the design results based on the flow diagram in Figure 1 with the concepts that have been carried out including morphology, function diagrams, go and no go, table basic decision is very effective to choose the best concept so that it can be concluded as follows:

1. Based on the concepts outlined above, one selected concept as follows: Concept 1: 1A - 2A - 3A - 4A - 5A, namely circle body cross-section, Ink tube with Gel, removable front cover, end cover can be rotated and grip using coconut shell. From the calculation of weight obtained the product concept that has the highest score is the first product concept with a weight of 43.
2. With the same pen diameter design which is 8 mm,
3. Around pen design is chosen which is the choice of the circle body section, Ink tube with Gel,

removable front cover, end cover can be rotated and grip using coconut shell.

4. Coconut shell pen products have specifications:

Material	: Aluminum
Body	: Circle
Grip	: Coconut shell
Length	: 125 mm
Diameter	: 8 mm
Ink	: Ink Gel / 4.0 mm
Weight	: 0.025 kg
Color	: Silver

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