



De Stijl Style Board Design of Waste Processing of HDPE and LDPE Plastic Bags

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ABSTRAK

Classification of plastic bag waste made from HDPE and LDPE based on color, white and black are produced in dominant quantities. Through the experimental method, heating on a gas stove at a temperature of 40-70°C is used to melt the plastic bag waste to produce a mold. De Stijl's style in Piet Mondrian's 2D work is used as the basis for compiling the composition of the printout in the form of a square board. Selection of the optimal shape and size of the mold is needed to be able to realize the shape of the board. The De Stijl style is one of the modernist styles that is still used today. The design method is used to realize the arrangement of the prints into a square board shape with a color composition in the style of De Stijl's modernism. The shape of the board is used to make furniture products, it is necessary to strengthen the form of the board. Reinforcement using the FRP method, because it does not change the composition of the design style of the board.

Keywords: De Stijl, Boards, Plastic bags, Trash

ABSTRACT

Pengklasifikasian sampah kantong plastik berbahan HDPE dan LDPE berdasarkan warna, dihasilkan warna putih dan hitam dalam jumlah dominan. Melalui metode eksperimen, pemanasan diatas kompor gas bersuhu 40-70°C digunakan untuk melelehkan sampah kantong plastik tersebut untuk menghasilkan cetakan. Gaya De Stijl pada karya 2D Piet Mondrian digunakan sebagai dasar penyusunan komposisi hasil cetakan berbentuk papan persegi. Pemilihan bentuk dan ukuran cetakan yang optimal diperlukan untuk dapat mewujudkan bentuk papan tersebut. Gaya De Stijl merupakan salah satu gaya modernisme yang masih digunakan pada saat ini. Metode desain digunakan untuk mewujudkan susunan cetakan menjadi bentuk papan persegi dengan komposisi warna bergaya modernisme De Stijl. Bentuk papan tersebut digunakan untuk membuat produk furnitur, maka diperlukan perkuatan pada bentuk Papan tersebut. Perkuatan digunakan metode FRP, karena tidak mengubah komposisi gaya desain bentuk papan.

Kata kunci: De Stijl, Kantong plastik, Papan, Sampah

INTRODUCTION

The results of processing plastic waste through recycling, reuse and reduction processes have been widely used as alternative fuels[1]–[4], furniture products and fashion products. The shape of the resulting product is made based on design principles. An effort to process this waste is carried out by CV. Robries Indonesia uses HDPE (high-density polyethylene) and PP (polypropylene) plastic waste to make furniture and board products using a plastic smelter and printer[5]. The manual moulding technique has not been used in producing the product because there are several weaknesses in the product, including the product is not strong enough to withstand the load, the mould is not

evenly distributed, and the area is not wide (maximum 100mm x 100mm). This is the reason for research to utilize manual moulding by arranging the printouts based on the colour of the available waste materials into products, namely boards.

The board is not strong enough to withstand a load of 108kg for 5 minutes [6]. Reinforcement is required on the board. The FRP (Fibre Reinforcement Polymer) method of strengthening, as has been done in previous studies, will be used for the design of this board. On page 14 of the journal, it is mentioned that the reinforcement construction on the corncob board construction uses FRP reinforcement. The fibre used is random fibrous glass, and the polymer used is polyester resin with code 157 [7].



Figure 1. Heating Process with Stove [8]

Plastic bag waste materials for research were selected from HDPE and LDPE (Low Linear Density Polyethylene) materials and from shopping plastic bags and plastic packaging bags because they have a melting point below 70°C. This has been done by Iyus Kusnaedi. According to him: the process of heating with a stove (picture 2), printing with wood prints, combining patterns with glue, and making interior lighting armature products are carried out through experimental methods on PET (Polyethene Terephthalate) and HDPE plastic waste. The PET plastic heating process uses a stove with 47–70°C [8]. The process of moulding melted plastic bag waste was studied from the results of the Gumulya experiment. The technique used in this research is the moulding technique and the hot press technique. Heating plastic bag waste using an oven temperature of 200°C for 5 minutes results in an abstract textured print, and there is a black colour because it is charred [9].

Plastic bag waste was obtained from the Surabaya Main Waste bank located on Ngagel Timur Street, Number 26, RT.009/RW.06, Pucang Sewu, Gubeng District, Surabaya City, East Java; and from household waste. The results of observations in 1 kg of plastic packaging bags and shopping plastic bags obtained from the Surabaya waste bank and household waste were obtained in six colour groups. The estimated percentage of colours in 1 kg of waste is 39% white, 29% black, 15% red, 10% blue, 5% yellow, and 2% other colours, in the form of the following chart:

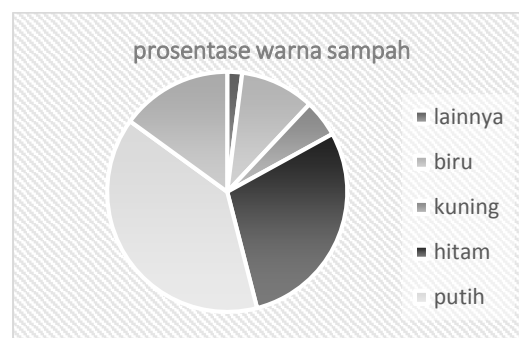


Figure 2. Color percentage chart in 1kg plastic bag waste
Source: Ningroom Document, March 2022

With the availability of these colours, a De Stijl style colour composition can be arranged. The composition of white and black will dominate the design because these colours are widely available in plastic waste. The work of De Stijl's modernist figure, Piet Mondrian, was used as the basis for the composition of colours and visible shapes of the board.

LITERATURE REVIEW

Board Design Style

Piet Mondrian's works (figures 3 and 4) have the characteristics of using rectangular geometric shapes in various sizes, compositions of red, blue, yellow and black lines, where the compositions are arranged in asymmetrical and abstract ways; be the inspiration for the composition of the shape and colour of the board. To obtain an optimal production speed, a rectangular mould with one size is used, the size of which is adjusted to the best density of the mould. As stated by Anthony Zonaga in his article on De Stijl, The primary characteristic of De Stijl is a pure universality through the reduction of elements to the bare essentials of form and colour, particularly the use of horizontal and vertical lines in conjunction with black, white and the primary colours. In 1914, Piet Mondrian, an important contributor to De Stijl [10]. Articles in Artland magazine confirmed the characteristics of De Stijl through the work of his character. In 1917, two pioneering Dutch abstract artists, Piet Mondrian and Theo van Doesburg, founded De Stijl. Originally a publication, De Stijl, which means Style in Dutch, was a magazine where the artists promoted their ideas on art and abstraction. De Stijl soon became a full-fledged movement that advocated a visual language consisting of precise geometric forms (primarily straight lines, squares and rectangles) and primary colours [11].

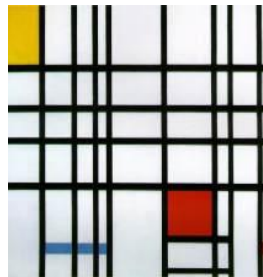


Figure 3. Piet Mondrian's 2D work in 1937-1942.
Source: creative5uite.wordpress.com/44, accessed March 2022

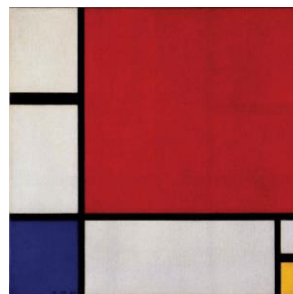


Figure 4. Piet Mondrian, Composition II in Red, Blue, and Yellow, 1930.
Source : Art Movement: De Stijl - Artland Magazine, accessed March 2022

Board Shape Composition

The plastic bag waste prints produce raw material with a complementary triad colour composition (figure 5), white and black. On the Munsell colour wheel (figure 6), white and black are called non-colours. The printout is made in the form of a rectangular geometry to speed up the production process to create a board in the style of De Stijl's design which has a solid and rigid character to look intense.

There are five contrasting colour combinations: complementary, complementary split, complementary double split, triad, and tetrad. Complementary colours are colours that are opposite to the colour wheel that is applied in design/artwork. Triad colour is the selection of three colours on the colour wheel that form an angle of 120 to each other [12].

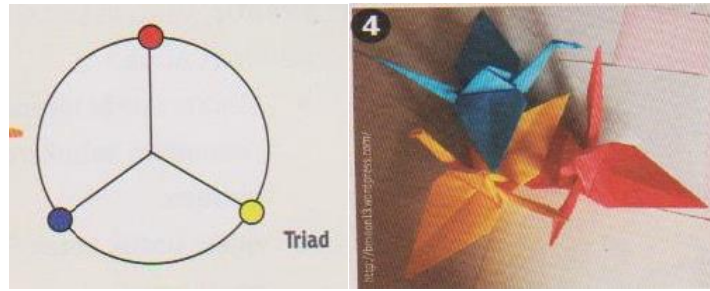


Figure 5. Complementary triad contrast color combinations in red, blue and yellow
Source : Design Fundamentals, 2013 : 63

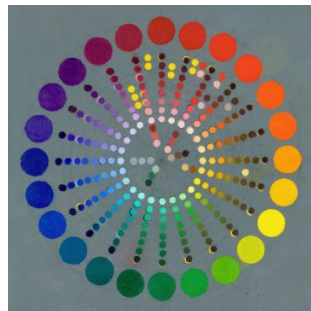


Figure 6. the Munsell Color System
Source: Pinterest, 2022

With the plural form transformation method with the arrangement attached (figure 7), the geometric shapes of the printed results can be made into a rectangular board as well. As Priscilla and Bambang wrote, form transformation in plural forms is not only done by grouping two or more masses but can also occur by placing several states that adhere to the axis system. The appearance is seen as a whole, not as a unit of transformed objects. The transformation of plural forms can be carried out in various ways, including: by placing them close together, by placing them together, merging some of each paper, attaching them to each other or grouping the masses of states with an axis system [12].

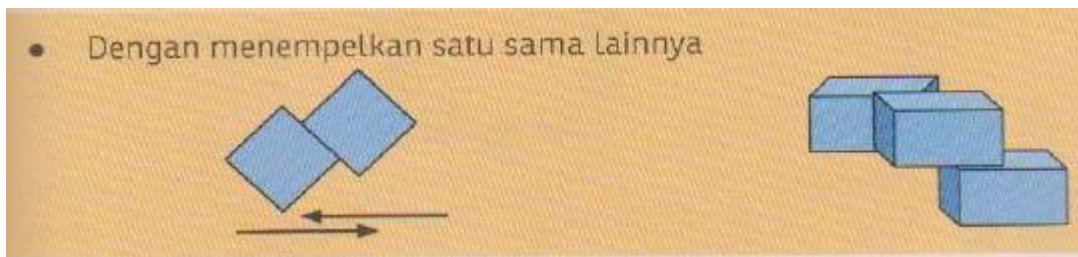


Figure 7. Transformation of plurals by pasting each other
Source : Design Fundamentals, 2013 : 87

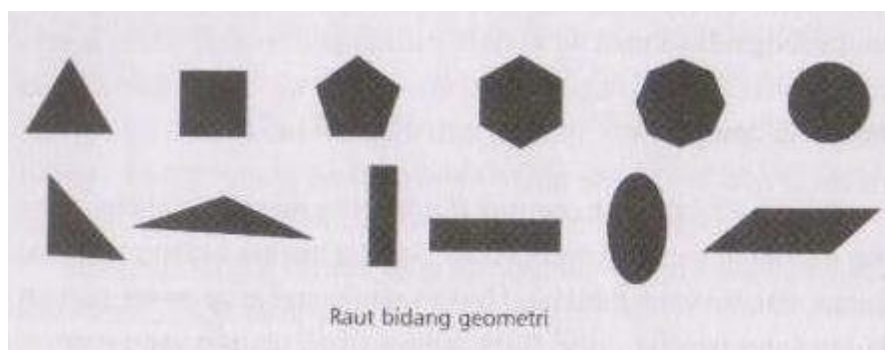


Figure 8. Some features of the geometric plane [13]

This board is a rectangular geometric plane (figure 8) formed from several rectangular geometric planes, which are arranged based on plane ladder intervals and the resulting arrangement of repetition fields with the same plane shape so that it looks static and neat. The printed areas are arranged in a row close together to appear unified and solid.

The various forms of the field include geometric and non-geometric fields. Geometric planes are regular planes made mathematically, while non-geometric fields are fields created independently. Geometry fields or fields are made mathematically, including triangles, quadrilaterals, pentagons, hexagons, circles, etc. A field is a form that has dimensions of length and width and covers an area. Fields have shapes, sizes and directions. Each has a role in shaping the beauty of art and design. To activate its role, the field can be worked on through the respective ladder intervals, namely the field level ladder interval, field size ladder interval, field direction ladder interval. Based on the plane ladder interval, among other things, the following plane arrangement can be produced: plane shape arrangement with one ladder interval (same plane shape). This arrangement is called repetition. The result is monotonous, there is a neat formal impression, but it looks static and boring. Various kinds of collection of planes and their effects, among others: the arrangement of planes lined up close together (clustered) looks more unified, the structure of the planes in contact looks unified but densely tense [12].

Plastic Bag Waste Material

From the observations, the types of plastic materials in shopping and packaging plastic bags are LDPE and HDPE. The physical characteristics of the two plastic bags are different. For materials from LDPE, the plastic bags are transparent, and if they are coloured, they will give a transparent colour (e.g. transparent red, transparent yellow, etc.) and glossy (figure 10); In contrast, the plastic bags are opaque and solid for HDPE materials. If coloured, they will give a more transparent colour (e.g. red, yellow, white and so on) (figure 9).



Figure 9. a) White opaque plastic bag waste b) Solid color plastic bag waste
Source : 7 Types of Plastic Bags and Their Functions - Asset.co.id, accessed March 2022

According to Solaeman Nur Rahman, the plastic bag (in Figure 9) has the chemical structure of HDPE, so it has good resistance to high heat. The high-density structure of the plastic polymer molecules in this plastic makes it more resistant to heat. There are three categories of plastic made from HDPE, ranging from plain HD (high-density) bags (polybags), HD crackle bags (shopping bags), to HD garbage bags (disposal bags) [14].

The advantages of plastic properties made from HDPE, according to acmeplastic.com, are as follows:

- Easily Meltable and Moldable
- Corrosion Resistance
- Large Strength to Density Ratio
- Easily Recycled [2], [15].



Figure 10. Transparent colored plastic bag made of LDPE
Source: waste4change.com, accessed November 2020

From Jatmiko and Zulnazri, plastic bag waste made from HDPE and LDPE can be melted down and manually moulded into other shapes through heating. HDPE and LDPE plastic bag waste materials can be obtained from household waste. According to Surono from Jatmiko, plastic bags made from LDPE (Low Linear Density Polyethylene) are found in plastic bags, plastic caps, frozen meat wrappers, and various other thin plastics. LDPE plastic bags are usually used for plastic garbage bags and clear plastic bags for drinks or food because of their shiny physical character. They can be produced in transparent colours. Based on their properties, plastics can be grouped into two types, namely thermoplastic and thermosetting. Thermoplastic is a plastic material that can be recycled and made into other forms of material through a heating process when used to create certain materials. Examples of thermoplastics include Polyethylene, Polypropylene, Nylon, Polycarbonate. Thermosetting is a plastic that cannot be melted down for recycling or other products once made into specific material. Examples of thermosetting plastics include Phenol formaldehyde, Urea Formaldehyde, Melamine Formaldehyde[1].

According to Zulnazri, the plastics used today are synthetic polymers made from chemicals that cannot be degraded by microorganisms, including high-density polyethene (HDPE), low-density polyethene (LDPE), polypropylene (PP), polyethene terephthalate (PET), and others. The plastic is disposable and cannot be reused, making it waste in the environment. This plastic can threaten the survival of living things on earth. Efforts to reduce environmental pollution can be made by recycling plastics by depolymerizing the plastics into other products [13].

METHOD

The method of processing plastic waste into rectangular moulds through heating and moulding techniques is the experimental method. The practical method, according to Borg & Gall (1983) (Jaedun, 2011), experimental research is the most reliable scientific research (the most valid) because it is carried out with tight control of confounding variables outside the experiment [16].

The Design Method was used to create a De Stijl style geometric composition board shape. The colour arrangement and the printed area are made in the form of rectangular geometry. The use of complementary triad colours of red, blue and yellow with contrasting colour compositions supports De Stijl's design style. White and black are not colours, but both result from the colours found in plastic bag waste. In Piet Mondrian's design style, both colours are part of the composition. So the addition of white and black colours will strengthen the type. The top view of the board results from the transformation of the plural form by attaching the melted plastic moulds using epoxy glue.

RESULT AND DISCUSSION

The experimental process begins with the preparation of materials. Plastic bag waste from the waste bank is sorted according to cleanliness and dryness. Clean and dry plastic bags can be used directly as materials. Dirty ones must be washed first with dish soap and water, then dried. Drying is done under the sun and aerated naturally. This natural drying process takes approximately 24 hours. After the plastic bag is clean and dry, the following process is colour sorting. The colours used for plastic bags are red, yellow, blue, white and black, by De Stijl's design style, which often explores these colours. The heating and printing process is carried out after the colour sorting process. Heating is done over a fire on a gas stove with a moderate temperature ranging from 40-70°C. Heating was carried out on an aluminium plate lined with parchment paper that had been smeared with silicon oil (figure 11). A layer of silicone oil prevents the melted plastic bags from sticking to the parchment paper and aluminium plates. A parchment paper base is used so that the melted plastic bag does not stick to the aluminium plate.



Figure 11. heating a plastic bag on an aluminum plate on a gas stove fire [6], [7]

From several experiments, the process of melting plastic waste is obtained as follows: First, before being baked on an aluminium plate, the plastic waste is weighed 70g and shaped like a ball, then baked for 40 minutes at a temperature of 40-70°C. Second, melting plastic bag waste uses a medium temperature of 40-70°C so that the melted plastic does not burn. It is easy to print with evenly solid results and not hard after dry prints. (figure 12a). Third, when in the oven, the melted plastic is always turned manually to melt evenly. Fourth, the melt is placed in the mould after evenly distributing the melt. Fifth, the melt is flattened in the mould and then pressed with a rogue for 10 minutes to evenly distribute the mould pressure. Sixth, the prints are removed and then sanded with a size of 80-100 on all surfaces with a grinder for 30 seconds to make them smooth.

The length and width of the printout are determined to be 100mm x 50mm. This site is used to make boards for tables 400mm x 400mm and boards for stools measuring 350mm x 35mm. Size The length and width of the pegboard are multiples of 100mm and 50mm, for example, measuring 600mm x 600mm, or 400mm x 600mm and so on. The mould is made of wood and is rectangular. The problem faced in wood moulds is that there will be cracks at the base of the mould due to heat and pressure during the manual plastic moulding process. This causes a similar mould to be made again so that the print results are even on all sides. The mould is made only one size to facilitate forming the board. The surface texture obtained from the results of each print is abstract because there are transparent plastic bag waste materials and solid colours. The printout of acceptable coloured plastic bag waste produces low colour intensity (opaque), and solid coloured plastic bag waste has medium colour intensity (transparent colour) (figure 12a).



Figure 12. a) white abstract printed surface
b) equilateral rectangular board measuring 35mm x 35mm x 11mm

Source: Ningroom document, 2022

Indicator prints with good results can be observed from the density of the printouts that are flat (no holes or empty gaps). From several experiments with the thickness of the mould, the results obtained are solid and flat prints with thicknesses ranging from 11-13mm. The density of images with a thickness of less than 11mm is not good because many gaps and empty holes are found. In contrast, the density of the mould with a thickness of more than 13mm will produce a hole/gap in the centre of the mould due to uneven heating in the centre of the melt. Rectangular geometric shapes with primary colours (red, blue and yellow) and not colours (black and white) on prints measuring 50mm x 100mm x 11-13mm, making it easier to compose a board composition in the form of an equilateral rectangle or shape rectangular. The percentage of white plastic bag waste material is higher, so a board with a white colour composition is more dominant. The rectangular prints are arranged in a straight line in the vertical and horizontal directions to form an abstract colour composition. The arrangement of vertical and horizontal directions is used onboard products, so that

plastic bag waste is not wasted during the board formation process. The percentage of the composition of the white and black areas dominates the visible board. A box-shaped board resulting from the arrangement of rectangular fields by affixing them to one another (figure 12b).

Attaching the prints to make the board is done with the help of epoxy glue to glue the sides of the images. Before being glued, the sides of the mould were sanded with sandpaper for wood size 100 to obtain a strong adhesion. After being glued to form a board, the top and bottom sides are sanded with 300 wood sandpaper. Sanding is done with electric sandpaper such as a grinder or sander. This form of the board can be applied in making stool designs, corner tables or pegboards. The underside of the board is reinforced with a black 157 polyester resin moulding layer and random glass fibre using the FRP (Fibre Reinforcement Polymer) method. For stool and corner table products, the construction of the chair or table legs used wood measuring 30mm x 40mm and finished with white and black paint (figure 13b and 13c). As the following design results:



Figure 13. a) peg board size 600mm x 600mm x 15mm
b) stool (chair without backrest) measuring 350mm x 350mm x 400mm
c) corner table measuring 400mm x 400mm x 400mm

Source: Ningroom document, 2022

CONCLUSION

The sorting of HDPE and LDPE plastic bag waste by color resulted in red, blue, yellow and not color that is white and black (which dominated the volume). With the experimental method, the waste is treated by heating at a moderate temperature of around 40-70°C on the stove and printed on wood molds using manual techniques. A rectangular geometric shaped mold measuring 50mm x 100mm x 11-13mm is used to make an equilateral square or rectangular board. The modernism of De Stijl by Piet Mondrian became the basis for the inspiration for the composition of the prints which were arranged in repetition with asymmetrical and abstract compositions. rectangular printout are used to speed up the production process of making boards. The color composition of the board uses a contrasting Triad color arrangement (red, yellow and blue) and white and black to form a board in the style of De Stijl modernism. Using the FRP method, the bottom of the board is reinforced with a layer of black 157 polyester resin and random fiberglass. the boards are used in the manufacture of pegboard products, corner tables and benches in the De Stijl design style.

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