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## Application Research on Product Visual Packaging Design Using Waste Materials

Rui-Lin Lin\*, Yeh-Hung Tseng

Department of Visual Communication Design, Chienkuo Technology University, Taiwan

\*Corresponding author e-mail: [linrl2002@gmail.com](mailto:linrl2002@gmail.com)

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**Abstract** This instructional application research recognizes the long-term environmental damage caused by humans, resulting in climate change and global warming, which has led to species extinction and food shortages, posing survival threats. Therefore, only by reducing material waste, conserving energy, reducing carbon emissions, and recycling and reusing resources can we mitigate environmental destruction under the concept of sustainable development and provide a better living environment for humans. Under this premise, this instructional application research aims to incorporate the concept of waste recycling, reuse, and redesign into professional courses on product visual packaging design. By engaging students in practical projects that creatively reuse waste materials, the study aims to strengthen their understanding of environmental concepts and their skills in designing with recycled materials. Subsequently, students will engage in practical creative projects to enhance the aesthetic value and appreciation of recycled materials. Finally, the creative results will serve as applications for professional design practice teaching and as references for future curriculum planning.

**Keywords** Waste Recycling, Product Packaging, Packaging Design, Visual Design.

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### 1. Introduction

This instructional application research aims to conduct product visual packaging design through waste recycling and reuse. The study is motivated by several factors. Firstly, the importance of environmental protection has been strongly emphasized by the government due to climate change, global warming, and the ensuing energy crisis in recent years. Teaching should advance with the times by incorporating environmental concepts into the educational units on packaging materials in design education. Secondly, this research integrates the concept of environmental protection into the teaching applications of professional courses in visual packaging design, hoping to instill in students a sense of valuing and cherishing resources, and understanding how to apply these concepts in the use of packaging materials. Thirdly, this research involves signing industry-academia agreements with companies to foster a cooperative relationship between industry and academia. This collaboration aims to provide students with direct access to practical skills and relevant information on the demands for design talent, offering them more learning opportunities. Finally, this research integrates the design methods of waste recycling and reuse with the concept of industry-academia cooperation into the development and application of teaching units for professional courses in packaging design. This approach aims to provide students with diverse practical experiences and training in the application of packaging materials, enhancing their practical skills. Moreover, it can serve as a reference for future fields related to design.

This study aims to integrate concepts of energy conservation, carbon reduction, environmental recycling, and industry-academia collaboration into the teaching applications of professional courses in visual packaging design. The goal is to transform what might have been vibrant and flashy packaging designs into those utilizing waste recycling and reuse methods. The first objective is to convey to students the idea that designers should protect the environment and cherish resources. Secondly, this study collaborates with industry partners to



discuss the appropriateness of the teaching unit design and planning for the creative theme. Following this, subsequent packaging visual designs utilizing waste recycling and reuse are carried out, serving as references for future packaging designs of related products by companies. Thirdly, the study aims to help teachers and students apply waste recycling and reuse design methods and gain a better understanding of the concept of industry-academia collaboration, thereby enhancing practical creative abilities. Finally, the results of this instructional application research can be used by students for learning, by teachers for teaching, and by companies for developing cultural and creative products.

## **2. Literature Review**

Given the widespread and continuous deterioration of the global environment, public awareness of environmental protection is steadily increasing. Governments and businesses play crucial roles in promoting public acceptance of eco-friendly products and enhancing awareness of resource recycling to achieve sustainable development. Consequently, scholars have investigated how gamification mechanisms on websites influence users' intrinsic motivation and satisfaction with the need for resource recycling, as well as how environmental issues moderate the relationship between intrinsic motivation and user participation. The study results indicate that gamification mechanisms can create intrinsic motivation in users and promote the satisfaction of psychological needs through mechanisms such as self-expression, points rewards, and competition [1][4].

Scholars have explored whether incorporating ecological elements into packaging design can impact consumer behavior regarding food waste and tested their perceptions of such packaging. The project included visual redesign and the relative use of textual language, aiming to reduce food waste. The results revealed that packaging design incorporating ecological elements can indeed reduce food waste, with particular effectiveness observed in resealable packaging and the use of visual elements [7][2].

The process of secondary resource recycling is complex and requires the participation of consumers, recyclers, and government entities. However, in developing countries, illegal recyclers not only have a cost advantage over legitimate recyclers but also cause severe pollution, which needs to be addressed and regulated. It is recommended that government authorities adopt different policy combinations at different times based on the conditions of the recycling market to achieve optimal outcomes for the recycling and utilization of secondary resources [8].

A low-carbon economy is an economic model based on low energy consumption, low pollution, and low emissions. Energy-saving packaging design, guided by the green psychology of consumers, directs the practice of reform and development. This approach uses the concepts of modern ecological and environmental green design as the main standards for packaging design applications. To change the current situation, it is necessary to combine people's established green psychology and find solutions for green packaging design. Therefore, studies have applied the concepts of energy conservation and carbon reduction to strengthen the development of packaging design, utilizing artificial intelligence (AI) technology to integrate market demands with green environmental design, thus improving product utilization and production efficiency. Furthermore, for the long-term benefit of human survival, it is recommended that packaging designers re-examine the relationship between design and the natural environment, reduce pollution elements in packaging design, and prioritize environmental protection as a key aspect of their work, establishing environmentally friendly design concepts. AI packaging technology achieves better integration and management of information provided by product packaging, helping people better understand the products, which is significant for the development of low-carbon product packaging [6].

The concept of recycling and environmental reuse within a circular economy has been pervasive over the years, encompassing waste management, materials, and supply chains, with packaging being a crucial component in realizing a true circular economy. Some emphasize that resources should be kept in a closed loop to achieve zero waste. However, due to the nature and specific uses of packaging materials, coupled with the packaging industry's foundation on a linear model, the design, production, consumption, and disposal of packaging generate significant waste, which has become a growing concern for the Earth's ecosystem. To achieve a smooth transition from a linear system to a circular system, packaging design is widely recognized as a fundamental stepping stone towards a circular economy [10].



Additionally, some scholars believe that creativity is a continuously evolving field in retail research. Therefore, they have explored creativity in packaging design, using the optimal arousal theory to examine the dimensions of packaging design creativity, such as differentiation and relevance, and how these factors impact customer processes, persuasiveness, and responsiveness to varying degrees. The study results revealed that, compared to earlier research focusing primarily on advertising contexts, the impact of packaging design creativity exhibits significant differences in the retail environment. These findings indeed provide new insights and revelations for retailers, packaging designers, and brand managers on how creativity influences customer decision-making [5]. Traditional manufacturing methods like inkjet printing, gravure printing, and screen printing are expensive. Nowadays, 3D printing technology offers a cost-effective solution for creating intelligent systems using materials deemed safe and food-friendly by internationally recognized food regulatory agencies. The research emphasizes the importance of utilizing smart food packaging, which can prevent potential tampering, contamination, and food fraud. Moreover, using 3D printing technology to manufacture smart packaging and equipment can be cheaper than traditional methods. It can produce highly compatible, non-toxic materials and develop highly versatile smart components. This will make smart food packaging more widespread, thereby reducing food waste and preventing consumers from ingesting unsuitable food [3][9].

### **3. Research Methods**

The research methods for this instructional application research are described as follows:

1. Literature Analysis: Collect and study literature related to the research topic, then organize, summarize, and analyze it to form the theoretical foundation for this study.
2. Case Study: Conduct case studies using packaging design-related professional courses as examples, focusing on aspects such as graphic visuals and the application of three-dimensional packaging materials.
3. Qualitative Research: Explain the creation of visual design in packaging design-related professional courses, helping students understand its key characteristics and meanings. Subsequently, discuss and revise design results based on the recycling and application of waste materials. Finally, provide the results to companies as a reference for the development of future cultural and creative products.

### **4. Curriculum Planning and Application**




In recent years, global warming caused by climate change has enveloped the Earth as if in a thick greenhouse, trapping heat from the sun and leading to rising temperatures. This increase in temperature has triggered various extreme weather events, such as droughts, heavy rainfall, and heatwaves. The impacts of this phenomenon extend beyond temperature changes; it poses threats to various aspects of human life. Global warming not only affects the climate but also leads to large-scale species extinctions and food shortages, particularly affecting sensitive ecosystems. Human activities are largely to blame for these outcomes. To mitigate environmental damage and achieve a sustainable environment, reducing material waste, conserving energy, reducing carbon emissions, and recycling are essential practices. These measures can help delay environmental destruction and improve living conditions for humanity.

This instructional application research aims to integrate the concepts of material energy conservation, carbon reduction, and environmental recycling into the teaching and learning process of professional courses in packaging visual design. The study involves designing and planning teaching units to explain the characteristics and content of packaging design and graphic visuals. By collaborating with teachers and applying waste recycling and reuse methods in packaging design research, the results can serve as teaching materials, fostering students' environmental consciousness and providing references for companies developing visual packaging design for cultural and creative products. This research project combines waste recycling and reuse with industry-academia collaboration in the teaching application of packaging design professional courses. The main tasks are described as follows:

Explore the characteristics and implications of professional courses related to packaging design, collect relevant information on graphic visuals, packaging design, and packaging materials, and then organize, summarize, and analyze this data to form the theoretical foundation for research and instructional materials. In the first phase, the results of reusable packaging design using waste materials are shown in Figure 1.



- Next, integrate this concept into the teaching and learning process of professional packaging design courses, guiding students in the recycling and reuse of waste materials, and evaluating their results according to assessment criteria. Finally, provide outstanding works to companies as references for the development of future cultural and creative products, and compile the teaching results into unit materials for future instruction in packaging design courses. The results of the second phase of creation are shown in Figure 2.

Style	Name	Material	Description
	Deconstructed Collage Kraft Paper Box	Kraft paper	Disassemble damaged Kraft paper boxes, reassemble them with altered structure and paper direction, reinforce and reshape the style, breaking away from traditional paperboard structures.
	Double-layer Shoe Box	Cardboard and Thin Kraft Paper	Handcrafted box made in a drawer-style to represent the double shoe box concept, incorporating cut-outs suitable for finger insertion for easy pulling. The design allows access from both sides.
	Handcrafted Small Gift Box	Cardboard and Colored Wrapping Paper	Handcrafted box made using adhesive, with decorative wrapping paper enhancing the elegance of the small gift box. This method is suitable for recycling and reusing discarded edge materials.





Plastic Bag Extraction Shaped Box

Kraft Paper Box

Redesign and create a playful box shape using recycled cardboard, suitable for holding rolls of trash bags for easy extraction. The box can be hung on the wall, making it fun for children and serving as a teaching exercise.



Pet Gift Box

Kraft Paper Box and Tape

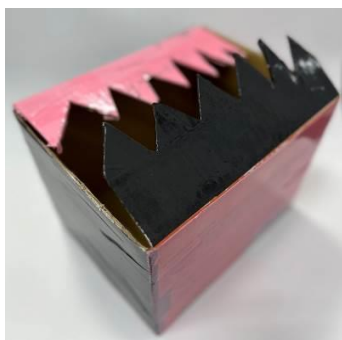
Pet Treat Box and Food Box, repurposing recycled cardboard into alternative box shapes for extended use.



Stationery Box

Kraft Paper Box Wrapping Paper

Repurpose recycled Kraft paper boxes to create custom-sized drawer boxes. Add patterned wrapping paper, handles, and other decorations to make a small drawer box for use on a desk as a stationery organizer.



Zigzag Box

Kraft Paper Box and Colored Tape

Repurpose recycled Kraft paper boxes by using colored tape to add color and decoration. The top is designed with a zigzag pattern, making it suitable for holding tissue boxes or roll paper. This design serves as a decorative box.



Box Decoration

Cardboard and Wrapping Paper

Disassemble the cardboard into smaller box sizes and reform it according to the box structure. Use a wet adhesive method to apply wrapping paper, enhancing the surface and transforming it into a new decorative box shape, giving it a new purpose and extended life.

Figure 1: In the first phase, the results of reusable packaging design using discarded packaging materials

Style	Name	Material	Description
	Egg Carton Packaging Protective Structure Triangular Prism Shape	Kraft Cardboard	The triangular structure is a more material-efficient packaging method that still provides good protection. However, due to its larger surface area exposed to the outside and lack of cushioning space, it offers basic protection under normal use but may not provide adequate protection against significant external forces.
	Egg Carton Packaging Protective Structure Square Box Shape	Kraft Cardboard	The box shape design facilitates easy retrieval and is suitable for arranging eggs in two rows. It offers flexible space utilization and provides good protection with a complete structure and adequate cushioning space. However, it does use more packaging material.



Egg Carton  
Packaging  
Protective  
Structure  
Carrying  
Box Shape

Kraft  
Cardboard

Combining the advantages of the two structures mentioned, the triangular carrying box shape offers benefits such as using less material and being easy to handle. However, the exposed egg surfaces are more prone to damage from collisions. Although the packaging allows for direct visibility of the egg's quality, which is a positive aspect, the insufficient protection means that extra care is needed during handling and transportation.



Egg Carton  
Packaging  
Protective  
Structure  
Combined  
Shape

Kraft  
Cardboard

The students jointly developed and researched the structure and shape of egg packaging with three main objectives: first, to ensure protective functionality; second, to minimize material usage and consumption; and third, to incorporate creativity and aesthetics. While the design focuses on a basic shape and conceptual ideas for packaging three eggs, practical applications typically involve 4, 6, or 12 eggs as standard units. Further work is needed to refine and strengthen the structure to produce a more streamlined egg carton with enhanced protective qualities.



Soap Gift  
Box

Colored  
Cardstock

Focusing on individual soap packaging, the small gift box design is open to creative interpretation. Students use their imagination to create various shapes and styles, often opting for drawer box designs or top-and-bottom lid gift box models. Some designs incorporate foil and Tetra Pak-style elements, with cone-shaped boxes adorned with decorations to create more extravagant packaging styles.



Handcrafted Box

Kraft Paper Card and Wrapping Paper

Handcrafted box design is well-suited for using eco-friendly and recycled materials. This approach is typically used for creating hard paperboard boxes that are ideal for packaging high-end, higher-priced items requiring enhanced protection. Due to the higher production cost, thick cardboard made from recycled materials is used internally, while thinner wrapping paper is applied externally using wet adhesive. The shapes are often square, round, or oval, providing value for collection or reuse. These boxes are commonly used for engagement gift boxes, perfume, wine, cigarette, luxury goods, and precious metal packaging.



Shaped Box

Sika Paper

Changing the shape of packaging can spark creativity. For instance, incorporating triangular patterns into a square box can transform it into a uniquely structured box, enhancing the intangible value of the packaged product.



Triangular Shaped Box

Recycled Kraft Paper

There are two design variations: one with a top and bottom lid, and the other with a triangular ring shape. These designs are suitable for packaging small pastries, cakes, sandwiches, or other gift items. However, they are intended to be assembled into a combination gift box with a unit of 8 sets.





Book-Shaped Box

Recycled Kraft Paper

Designing the packaging in the form of a hardcover book retains a large storage space while imparting an elegant, literary aesthetic. This design is suitable for repeated use and can even be placed on a bookshelf as a discreet storage space for other items, showcasing its multifunctional and creative design.



Square Top and Bottom Lid Shaped Box

Recycled Kraft Paper

Most standard box shapes are square, which maximizes internal volume and aligns with core packaging values and usage habits. The top and bottom lid design can accommodate heavier items and can also be used as a divider for storage and organization.



Heart-Shaped Box

Recycled Kraft Paper

Incorporating specific patterns into the structure can create a lively effect. This not only serves an aesthetic function but also introduces variations and uniqueness to the design, making the box a valuable item for collection.





Hexagonal  
Drawer-  
Style Shaped  
Box

Recycled  
Kraft  
Paper

This design is a hexagonal, long rectangular drawer box, ideal for storing cookies or flat items. The drawer style allows for clear display of the contents and helps keep items neatly organized. It is a gift box style with eco-friendly and reusable characteristics.



Gift Box  
with Lid  
Design

Recycled  
Kraft  
Paper

The gift box design features a display function, allowing the packaged item to be showcased elegantly. It is suitable for high-value items such as wine, perfume, and jewelry, and enhances the overall quality and perception of value. This design is ideal for creating high-quality, handcrafted, custom eco-friendly packaging.

Figure 2: In the second phase, the results of reusable packaging design using discarded packaging materials

**5. Conclusion**

The academic value of this teaching application research is described as follows:

1. Integration of Sustainable Concepts: This research integrates the concepts of material energy saving, carbon reduction, and environmental protection into packaging design courses. It encourages students to learn how to utilize resource recycling and reuse methods, making it a valuable approach for exploration and promotion.
2. Industry-Academic Collaboration: By incorporating industry collaboration into the teaching and learning process of packaging design courses, this research facilitates discussions, creation, and refinement of visual design and packaging materials. The outcomes provide valuable references for industry partners in the development of creative products, combining theoretical and practical aspects with academic value.
3. Collaborative Teaching Approach: The research employs a collaborative approach among teachers to explore and apply environmentally friendly concepts of recycling and reuse in packaging material planning and visual design. It enhances students' understanding of environmental care and resource conservation within the design profession. The results offer practical applications for future educators in teaching methods and provide reference value for related academic fields.



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