EdibleToy: Empowering Children to Create Their Own Meals with a DIY Wafer Paper Kit

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ABSTRACT

Existing methods in human-computer interaction to enhance children's eating habits predominantly rely on digital interactive technologies, which pose the risk of increasing sensory stimulation and diverting children's attention away from the food itself. Drawing inspiration from shape-changing food research, we propose an approach that combines deformable wafer paper for food preparation. We summarize the principles of wafer paper controllable deformation and develop a toolkit to facilitate its use. We support children in creating personalized, transformable food items using this method, aiming to provide a playful, convenient, and safe food-making experience tailored for children, thereby enhancing children's mealtime engagement and habits.

CCS CONCEPTS

• **Human-centered computing → Interaction design process and methods**.

KEYWORDS

Human-food interaction, Shape-changing Food, children, interaction design

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1 INTRODUCTION

Mealtimes are closely linked to the development of physical and mental health for young children. However, it's common for parents to struggle with children's eating problems such as selective eating and food refusal [4, 8]. Traditionally, parents often use methods to distract children's attention from food (e.g., having them watch cartoons) to feed their children during mealtime [6].

In HCI and IDC, a body of work has focused on designing digital interactive technologies to address children's eating problems. These approaches mainly involve offering fun and playful feedback [2], designing games [17], providing companionship through social robots [12] Nevertheless, there is a growing concern that such digital interactive technologies increase sensory stimulation [3], and potentially distract children from the actual meal itself [9], leading adverse outcomes.

Although gaining traction, it is under-explored in HCI how to encourage children to eat while not disrupting their attention from food or overly stimulating their senses. In this context, we recognize the potential of shape-changing food [7, 10, 14]in maintaining children's attention and engagement during mealtimes. Drawing inspiration from deformable food materials and paper toys [1, 11], we aim to create a playful, convenient, safe food-making experience tailored for children.

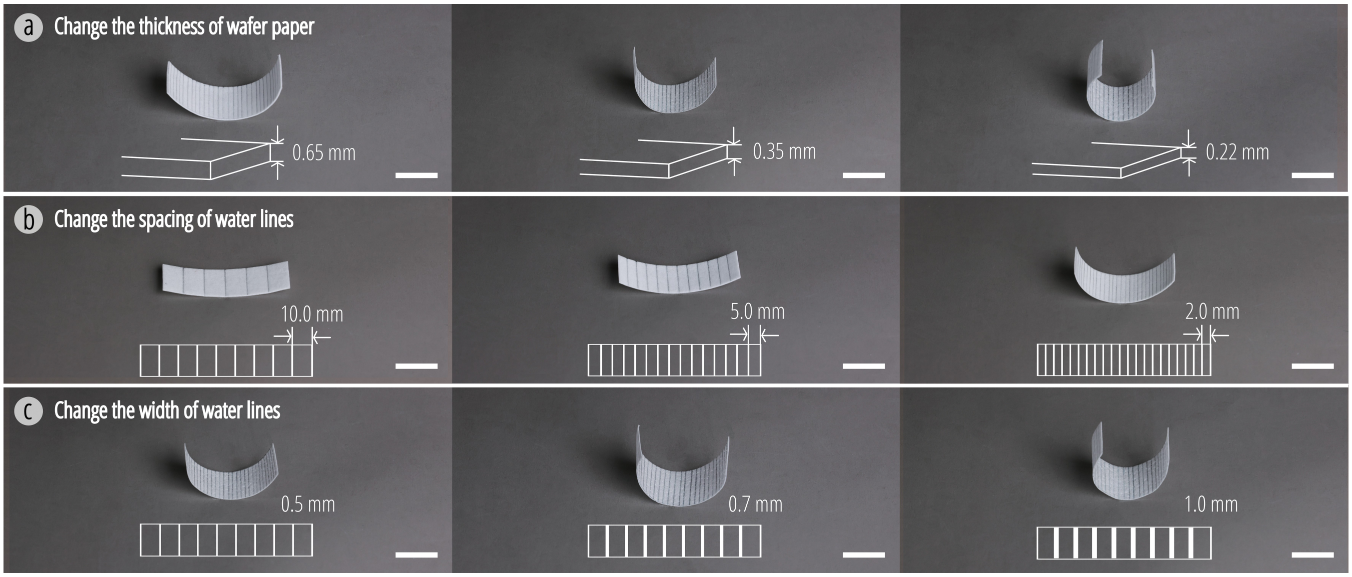

Figure 1: Deformation effect of wafer paper under different thickness, water line width and water line spacing. Scale bar: 20 mm.

We investigated the controllable deformation principle of edible wafer paper and explored the possibility of creating edible deformable toys. Using 3D printed molds, we created a DIY toolkit for wafer paper that allows children to conveniently focus on the food itself and enjoy a fun food-making experience and enhance children's eating habits.

2 RELATED WORK

To anchor the contributions of this work, prior research on designing for the children mealtime context is first reviewed. Research into the shape-changing materials and the paper toys for children also informed the direction of this work.

Prior studies in HCI have proposed various ways to enhance children mealtime experience and address children's eating problem. Most of them focus on using digital interactive technologies [2, 3, 12, 17].For example, Zhao et al. [17] designed an intelligent dinner plate system which can help children develop healthy eating habits through interactive animations. While there is also a growing body of work [5, 9] reporting that such interactive technologies may be associated with adverse outcomes (e.g., unwanted distractions [9]), particularly in relation to screen-based media. Therefore, the question of how to enhance children's eating habits while not disrupting their attention from food or overly stimulating their senses remains a gap. Prior work suggests that shape-changing food may be a potential approach for people to focus on the food itself while also making it a fun and enjoyable experience. For example, Morphlour is a type of deformable pasta that employs groove printing on flat dough, enabling it to change shape during cooking [14]. This technique has also been applied to purple mashed potatoes, where He C.et al. examined their spontaneous deformation under microwave dehydration using 3D printing [7]. Similarly, through extrusion principles, magashi, a transformable edible structure based on the properties of the printed material is develop [10]. Doleweerd et al. investigated edible paper preparation and origami deformation using chemical principles [15]. These studies primarily focus on utilizing physical or chemical principles to manipulate deformable materials, which might be more complex to handle and may not be easily comprehensible to children.

We are inspired by paper toys, a crucial initiation tool for children. They are often used in storytelling and teaching and can stimulate children's curiosity and creativity [13, 16]. Current research on the interaction of paper-based materials encompasses the utilization of movable paper techniques to develop assemble-yourself toys for children [1] as well as the integration of electronic technology to generate paper animations that capture children's curiosity [11]. These studies demonstrate that paper toys can offer simple and accessible experiences for children. It is worth noting that the context of mealtimes presents unique and distinct demands, such as the potential need for more convenient preparation methods. Therefore, it is essential for us to explore these specific requirements further.

3 BASIC DEFORMATION TEST AND DESIGN PROGRESS

We chose wafer paper as the material for food interactions during children's mealtimes. As a starch-based material, wafer paper is largely allergen-free, ensuring a secure experience for young children. Furthermore, its unique property to reshape when exposed to moisture allows for stable alterations and tailor-made designs, which has led to its widespread use in the food industry, including artistic edible decorations for cakes and eco-friendly packaging.

To investigate the deformation of wafer paper caused by water immersion, we conducted a series of experiments. We used an ordinary fountain pen as a tool to immerse the wafer paper and controlled the deformation by drawing water lines.

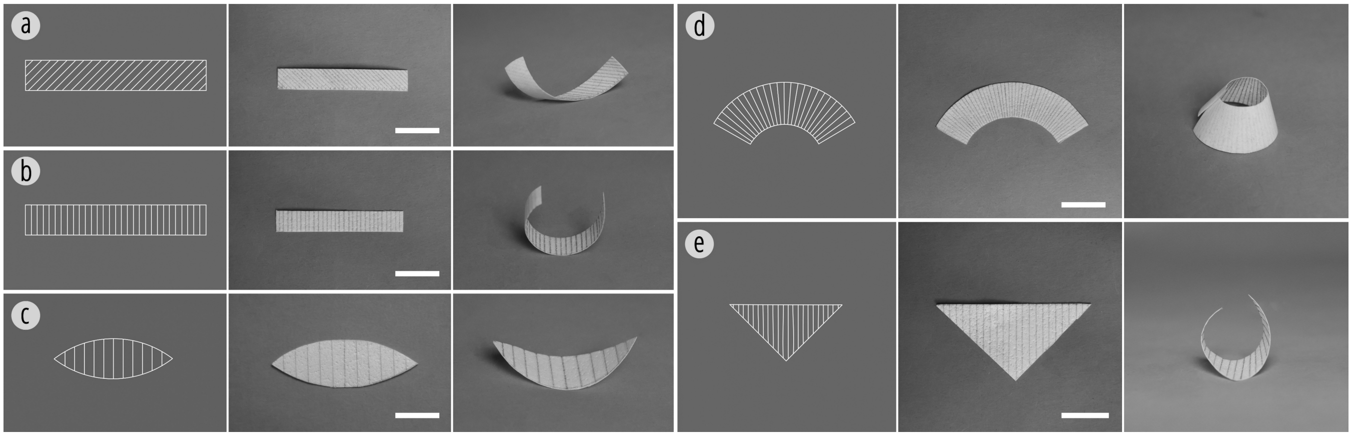

Figure 2: Primitive deformation library. Scale bar: 20 mm.

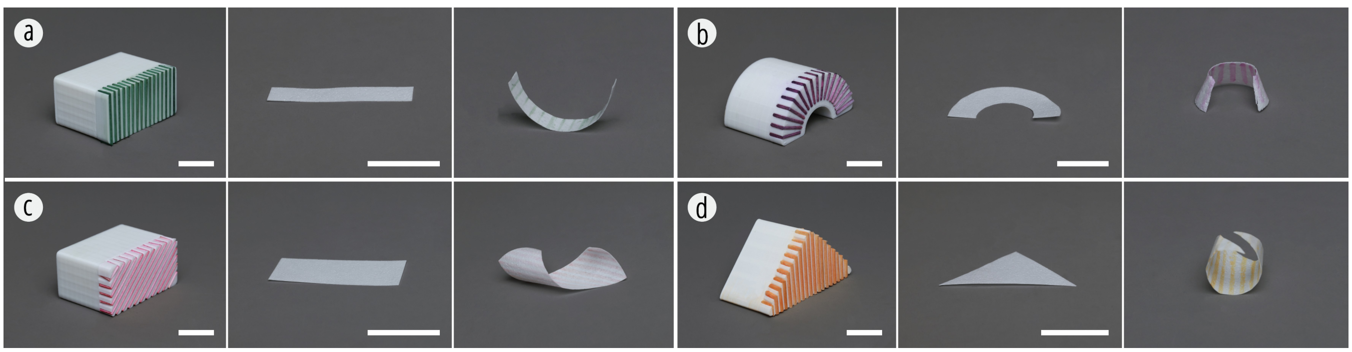

Figure 3: 3D printed molds and the actual usage effects. Scale bar: 30 mm.

Paper thickness: Distortion tests (Figure 1a) were performed on wafer paper of different thicknesses (0.22 mm, 0.35 mm and 0.65 mm) using the same pen and water lines spacing under controlled single variable conditions. Thinner wafer paper (0.35 mm and 0.22 mm) exhibited better curling effects under the same conditions of water line width and spacing, compared to thicker wafer paper (0.65 mm).

Spacing of water line: Different spacing of water lines drawn by the same pen, including 10.0 mm, 5.0 mm and 2.0 mm spacing, were tested on the same 0.22 mm thickness of wafer paper (Figure 1b).

Width of water line: Different thickness pens (0.5 mm, 0.7 mm and 1.0 mm width) were used and tested at the same spacing on the same wafer paper (Figure 1c). Wider water lines and closer spacing also promoted better curling effects.

According to the experiment result above, we utilized a 1mm width fountain pen to draw lines with a spacing of 2.0mm on wafer paper with a thickness of 0.22mm to create a superior deformation effect. Based on this parameter setting, we built a deformation library containing shapes such as waves, bars, leaves, sectors and triangles (Figure 2).

In our initial experimental tests with water paper material, we found that drawing multiple regular lines with a pen is challenging for children. Considering the accessibility for children as well as the need for convenience in preparing meals during mealtimes, we develop a set of fabrication tools to support children customizing deformation of wafer paper rapidly. Inspired by stamp that can imprint ink on paper yielded patterns with relatively uniform marks, we designed several molds (Figure 3) with different patterns and shapes. The main structures of the molds are PLA with 3D printing. Furthermore, polyester fibers are embedded at the bottom layer of the molds as they have a high moisture-absorption capacity. Pressing the fibers can effectively squeeze out the water, achieving the goal of wetting the paper. Figure 3 shows the deformation effects of wafer paper caused by these customized 3D-printed molds.

4 WORKFLOW AND APPLICATIONS

Building upon our basic deformation library, we have developed flower and animal shapes that not only visually appealing but also easy for children to eat (Figure 4).

These shapes can be efficiently formed by using our existing molds. For example, when children have a specific shape in mind, such as a flower (Figure 5), they can follow these steps:

1. Children can cut the wafer paper into flower petals, while we also provide pre-tested paper sheets with petal shapes for added convenience.

Figure 4: Applications based on basic deformation library. Scale bar: 60 mm.

Figure 5: The process of using our tools for food preparation.

2. Children can choose molds and edible solutions that will determine the color, flavor, and curvature of the flower (e.g. whether the petals are fully open or partially closed).

3. Children select foods and combine them with the wafer paper flower to create a visually appealing and appetizing dish.

4. Children apply the edible solution using a mold, causing the flat flower shape to curve and transform into a more realistic, three-dimensional form.

5. Children can then enjoy eating their flower creations, savoring each bite as they recognize the different parts of the flower, such as petals or the stamen.

Two children were invited to create a fruit platter using our interactive method. They are both 8 years old and have prior involvement in food preparation, including cutting vegetables, kneading dough, and making food platters. Before the experiment, we conducted interviews with the participating children and their parents, utilizing a structured format to elicit detailed information about their culinary experiences, dietary practices, and personal inclinations. We followed the aforementioned process to allow the children to conduct initial experiments. The children crafted platters with both preferred fruits (such as oranges and mangosteens) and non-preferred fruits (such as pears and avocados). They displayed a keen interest in edible paper materials, stating, "I never knew there were papers that could be eaten directly." Both fruits and edible paper were consumed by the children during the experiment.

Our interactive method transformed the children's attitudes towards fruits they had previously avoided, encouraging them to try new foods and broaden their culinary horizons. Additionally, their parents supported our approach to be effective in improving children's food-making skills and imagination. In future experiments, more rigorous psychological theories and user testing methods will be introduced to demonstrate the effectiveness of using shape-changing edible paper in enhancing children's food acceptance.

5 CONCLUSION AND FUTURE WORK

In this paper, we investigate the controlled deformation principles of wafer paper, and explore the possibility of creating edible shape-changing toys. Based on these principles, we conduct experiments on different shapes and build a preliminary library of material deformation. In addition, to adapt to different shapes of wafer paper, we design 3D printed molds to assist drawing. Children can easily use the molds to create deformation patterns on wafer paper with water. We also explored the combination of wafer paper with other food materials.

Future research will focus on developing user-friendly tools and a comprehensive toolkit for children to create personalized meals with wafer paper. Our goal is to establish a systematic toolkit that caters to children's needs for easy participation in food preparation while allowing them to conveniently express their creativity during mealtimes. Our study will also examine the integration of less appealing foods for children into the design process, assessing the convenience and effectiveness of this approach. We plan to conduct a series of user experiments to investigate how this method can address children's eating problems, promoting healthier food choices and enhancing more engaging mealtime experiences.

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