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Creative Fusion: Exploring the Convergence of Art, Science, and Education in Traditional Crafts through Bird-Inspired Design Techniques

Yikyong Kim[1], Narae Song[2], Boyong Kim[3], ChahngBaek Song[4], Suji Park[5], and Namsoo Peter Kim[6]*

[1]Gyeongbuk Institute for Bio industry (GIB), GyeongsangBuk-do, Republic of Korea
[2]Hemptosil, GyeongsangBuk-do, Republic of Korea
[3]Andong Science College, GyeongsangBuk-do, Republic of Korea
[4]Catholic Sangji College, GyeongsangBuk-do, Republic of Korea
[5]Department of Pharmaceutical Engineering, Daegu Haany University, Gyeongsan 38610, Republic of Korea
[6]BP Distinguished Fellow, National Research Foundation of Korea (NRF), Republic of Korea
*Correspondence to: Namsoo Peter Kim, E-mail: nsking21@gmail.com

Abstract

This paper highlights how, over the past 12 years, we have effectively applied the bird-inspired technique of VIZO design to create unique 3D products by filling three-dimensional voids and materials with continuous lines. It presents the possibilities of combining art and modern technology in a traditional craft and emphasizes the concept of creative fusion, which is material-independent and can convey emotion through a variety of media. The educational program leverages the interdisciplinary strengths of science, engineering, and art to make it accessible to the public, students, and professionals without prior artistic training. Students learned how to research and explore the creative intersection of science and art for educational purposes—an area that is often challenging for the general public due to limited access to materials such as biomaterials or hemp, as well as the use of equipment that is complicated to operate. The combination of modern technology and traditional art has opened up new avenues of creativity and self-expression. This paper is a first-hand account of the fusion of art and science in an interdisciplinary curriculum and the resulting final artwork. It presents an innovative attempt to combine traditional materials such as hemp with state-of-the-art 3D printing technology and successfully demonstrates the fusion of science and art.

Keywords: VIZO Design; Artistic 3D Printing; IoT control; Art and Science Convergence;

1. Introduction

Since the Neolithic era, which dates back to around 8,000 BC, the industrialization of ceramics has undergone significant advancements. The pinnacle of this progress occurred around 700 AD in the East and 1500 AD in Europe. The crucial factor determining the historical and cultural flourishing was the utilization of firing techniques, which varied depending on the ceramic material employed.[1] The art of ceramics, closely associated with high-temperature heat treatment, is believed to have originated in China. Over time, it spread to Korea and Japan along with the dissemination of firing techniques in the East Asia.

The history of ceramics reflects the history of mankind and is divided into different phases: the Crushed Stone Age, the Ground Stone Age, and the Earthenware Age. Based on ceramic artifacts, it is documented that ceramics began in China approximately 10,000 years ago. During this period, colors varied depending on the temperature and material of the firing process, resulting in corresponding changes in nomenclature.[2] The art of firing and ceramics transcended national and continental boundaries, adapting to the shapes and colors that suited the customs and times of each region. Throughout the Bronze and Iron Ages, it continued to evolve, eventually reaching the modern era while maintaining a fundamental reliance on ceramic materials. Jinsa ceramics using copper oxide film as a redox technology porcelain, which is made through reduction firing by adding copper oxide to the glaze, has been developed and refined. More recently, the technology has been integrated with 3D printing to

modify ceramic surfaces.[3] Despite challenges with curved surfaces and the durability of printed designs, the standardization of mass-production printing techniques has made it possible to apply two-dimensional printing methods to ceramic surfaces. These advances have paved the way for the transfer of special designs from plastic materials to ceramics in particular.[4]

Digital manufacturing (DM) has emerged as a crucial catalyst for the growth of Industry 4.0, capitalizing on advancements in 3D printing technology. DM facilitates the remote transmission of data and enables the efficient production of a diverse range of products in small volumes, precisely where they are needed. Just as the mastery of fire played a pivotal role in the ceramics industry's development in the past, DM is now recognized as a pivotal technology for revitalizing the contemporary ceramics sector in the future. [5] Acknowledging this potential, the authors of this paper have achieved significant progress since their initial endeavors in 2010. They are currently advancing towards industrialization by integrating DM with VIZO design techniques, which serve as the core technology for Artistic Smart Manufacturing (Artistic SM). [6,7,8]

Remote data transmission and precise shaping of materials has expanded into the realm of art. In December 2021, a designated location in South Korea, the SK Future Hall at Korea University in Anam-dong, Seoul successfully printed 3D VIZO ceramics using data transmitted from around the world. This development marks the convergence of science and art.[9] At Korea University in Seoul, as well as Seoul Biomedical 3D Printing, Yongsan Crafts Center in Seoul, Iguk Crafts in Gyeonggi-do, Gimhae Small Craft Center, Pocheon Youth Center, and VIZO Art Center in Yecheon, Gyeongsangbuk-do, we have prepared printers that allow consumers to create products of their own design using locally available files and materials. By overcoming the constraints of time and space, it became possible to print in multiple locations at the same time. Korea University also runs a three-week Artistic SM training program twice a year for international students with no craft experience.

The initiative introduced a two-way transfer of materials to the University of Texas at El Paso (UTEP) to foster artistic sensitivity among non-majors by transcending time and space barriers, resulting in the first successful printing. [10] In the realm of ceramics, the assessment of artistic value has traditionally relied on scarcity. However, unlike other artistic fields such as sculpture, oil painting, and watercolor, ceramic techniques were limited to a few potters. The lack of knowledge transfer to future generations, combined with the challenge of unclear authorship for many works, has posed difficulties in assessing the skills and expertise of potters. We remember the artists of ink and color paintings, but the creators of the famous Korea celadon and Joseon white porcelain remain largely anonymous. Inspired by this, the 3D VIZO art approach aims to strike a balance between commerce and artistic expression by protecting original designs from the public and maintaining scarcity through limited production quantities.

This approach specifically caters to Generation MZ, a demographic that prefers non-face-to-face services due to the COVID-19 pandemic and seeks training conducted in small groups. In an era where people crave educational opportunities and the chance to explore innovative endeavors that yield reproducible and unique artistic products, the convergence of science and art becomes essential. [11] The interdisciplinary fusion allows for the creation of limited yet replicable outcomes that retain commercial viability. Furthermore, the scalability witnessed in fields such as 3D tattoo artists and 3D nail artists, facilitated by the use of 3D printer equipment, paves the way for a new concept known as "3D VIZO artist." The convergence education emerges as a necessity [12].

2. Methodology

2.1. Arttistic Smart Manufacturing Education

In 2011, lead author Dr. Peter Kim introduced remote SM learning at the UTEP College of Engineering in the United States as a regular course called "Printable Materials. Consisting of three credits per semester, the course covered machine control, material synthesis, and 3D printer fabrication. Over time, design was recognized as an integral part of the education, and the VIZO design program was patented and developed to enable precise control of various materials within a set time frame.

Starting in 2017, although not specifically mentioned in this paper, we developed SM technology training through regular courses with a variety of participants, including members of the public with no prior knowledge of art, foreign exchange students, and professional artists. They were trained in VIZO 3D design technology and remote 3D printing technology to create 3D works that convey artistic value and evoke human emotions while emphasizing the preservation of scarcity. Figure 1-a presents an overview of the VIZO Design and SM training program, conducted over a span of three weeks at Korea University from 2021 to 2023. On the other hand, Figure 1-b provides a concise summary of the program [13].

The participants commence with a pre-training session that introduces them to the fundamental concepts of VIZO Design and 3D printing. They then learn how to generate their own designs using the VIZO Method, which distinguishes itself from typical three-dimensional designs by avoiding overlapping lines. During the final phase of the training, the international students are acquainted with traditional Korean folk paintings and guided through the process of simplifying their designs based on their individual sensibilities. This encompasses material preparation and instruction on printing techniques.

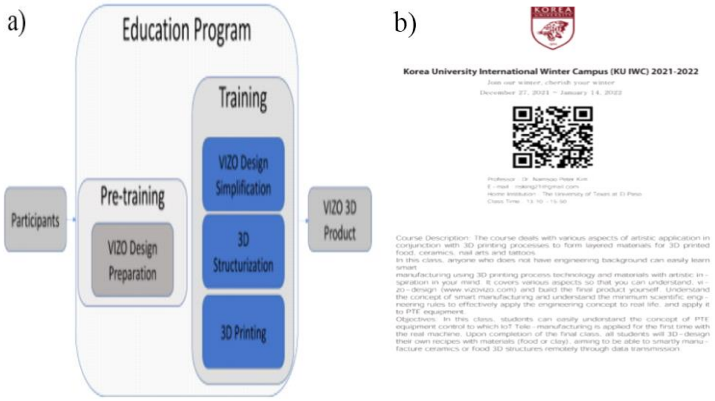

Figure 1. *a) Conceptual drawing of education program; b) Summary of International Winter Campu s (IWC) 2021*

2.2. IoT controlled 3D Printing Education and VIZO Design

The printing method, developed for remote control using IoT-based printers equipped with communication technology, is applied to a monkeybar-style printer equipped with a piston-type extruder (PTE) system for printing artwork on standardized clay plates. During the training, participants utilize Adobe Photoshop to simplify selected drawings into VIZO designs and modify them to ensure smooth connection between each line. The resulting designs are then sliced using the CURA program to facilitate 3D structuring. The generated G-code file from CURA is transmitted to the Monkeybar printer through a web platform for remote 3D printing. Trainees can acquire knowledge and hands-on experience in 3D printing while utilizing VIZO Design's printing materials, which encompass a variety of substances such as clay, slip, food, and biomaterials, to create their own unique creations.

For the PTE method, a mixture of slip and clay with appropriate proportions and dyes of various colors is used. Standardized clay plates, typically measuring 10x10 cm^2, are employed for training purposes. For non-practical artwork, these plates can be produced in a sequential manner or in different sizes, including small and intricate pieces. Following printing, the clay plates undergo a heat treatment process to fuse together and form a cohesive unit. To prepare the piston, a compound consisting of slip and clay with a ratio of 2:1 is filled into it. The slip possesses a specific gravity of 70% and the clay contains approximately 22-23% water. The size of the piston tip is 0.84 mm. The dye mixture is added to the prepared slip and clay compound to achieve color compositions resembling various types of food. Utilizing the IoT-based 3D printer, two- or three-layer artworks are then printed onto standardized substrates [14].

As part of the training program, students initially participated in a pre-curriculum session that involved a hands-on exercise. In this session, they were introduced to the 3D printing machine and tasked with

printing a design directly from a webpage, without making any modifications. The primary goal of this exercise was to acquaint the students with the 3D printing process and alleviate any initial unfamiliarity they might have had. The 3D printing process employed a standardized the PTE method, which entailed printing on a flat surface using optimized speed and material release rate. As time went on, the program authors made a significant discovery: achieving original artistic expression hinged on creatively applying design beyond the constraints imposed by the machine. They realized that encouraging students to think outside the box and push the boundaries of the machine's capabilities had a profound impact on their artistic output.

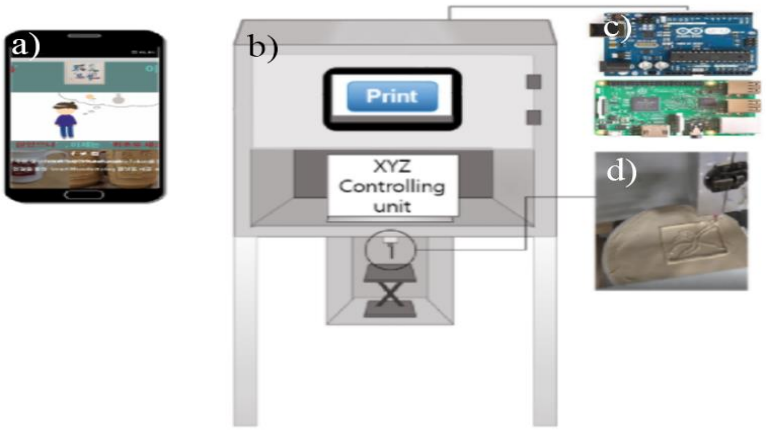

Figure 2. *Conceptual drawing of the process using an IoT printer:a) Web platform (www.vizovizo.com);b) IoT 3D Printer;c) Raspberry Pi & Arduino;d) 3D printing in progress*

3. Results

3.1. Arttistic Smart Manufacturing Education Using VIZO design

To deepen the students' understanding of design and its broader context, Table 1 was introduced. This table provides valuable background information on artworks by notable artists like Kim Jeong-hui, Kim Hong-do, and others. It sheds light on the intended meanings behind their creations, taking into account the historical and political context of their time. The inclusion of this table serves a dual purpose: to evoke emotions within the participating students and to teach them how to design using VIZO in a manner that enables the unrestricted communication of their intended expressions to others.

Table 1. Masterpieces of famous traditional Korean artists used in student designs and works of this study and their explanations

Title	Manufactuer	date	Size	Description
Sehando, (Winter Scene,歲寒圖, Figure 4-a)	Kim Jeong-hui	19c	23.7x108.2 cm^2	This work was created by Kim Jeong-hui, a renowned calligrapher from the late Joseon Dynasty, as a gift for his student, Sang-jeok Lee. The composition seamlessly integrates poetry, letters, and pictures, resulting in a harmonious yet evocative display. Through this piece, we witness a captivating interplay between dynamism and serenity. The theme of loyalty is eloquently conveyed, as depicted by a solitary house standing resiliently amidst the frigid winter, safeguarded by the presence of majestic Pine and Korean pine trees.
Hwajeopdo, (Flower and Butterfly,花蝶圖, Figure 5-a)	Nam Gye-woo	19c	28.2x 121.2 cm^2	On the elongated vertical canvas, the mesmerizing flutter of butterflies and vibrant hues come to life in stunning detail. The majority of the painting is adorned by enchanting wisteria and resplendent peonies, while the delicate presence of butterflies, meticulously positioned amidst the blossoms, adds a touch of serendipity to the composition. [15]
Pyongyang Gamsa Hyang yeon,(Welcoming Ceremonies for the Governor of Pyongyang,平壤監司饗宴圖, Figure 6-a and 6-c)	Kim Hong-do	18c	71.2x196.6 cm^2	This series of drawings portrays a grand banquet held in celebration of the appointment of the Pyongyang auditor. It comprises three distinct works: "Wolhaseonyudo," "Bubyeok-ro Banquet Map," and "Yeongwangjeong Banquet Map." Each piece offers a unique perspective on the festive occasion, capturing the essence of the event in its own distinctive style.[16]
Palgajo, (Bird, 八哥鳥圖, Figure 6-b)	Kim Hong-do	18c	32.5x23.8 cm^2	This artwork portrays a Palgajo, a bird known for its filial piety, gracefully perched on a diagonally lowered branch. At the bottom of the piece, the words "Imitated Imyang's Hwaui" are inscribed. The imagery captures the essence of filial piety as embodied by the Palgajo, symbolizing the noble act of providing sustenance to one's parents.

Figure 3 visually depicts the contrast between the basic control of the machine and the enhanced three-dimensionality achieved through stacking during the students' training as they print their prepared designs from the webpage. The figure highlights four distinct objects: a tiger (a-1), a sehando (winter house) (b-1), a mape (horse requisition tablet) (c-1), and a Ssirum, Korean wrestler (d-1). For the tiger, a three-dimensional effect was created by printing two layers with different designs. The results of printing a single layer are displayed as B-2, C-2, and D-2, while the outcomes of printing two layers with the same design are shown as B-3, C-3, and D-3. Printing the selected design once emphasizes a clear and distinct expression of the original. However, when the same design is printed twice, it effectively conveys a sense of depth and spatial characteristics compared to a single printing. Various printing techniques were employed, including layer stacking, repeating the same shape, and printing in the same location.

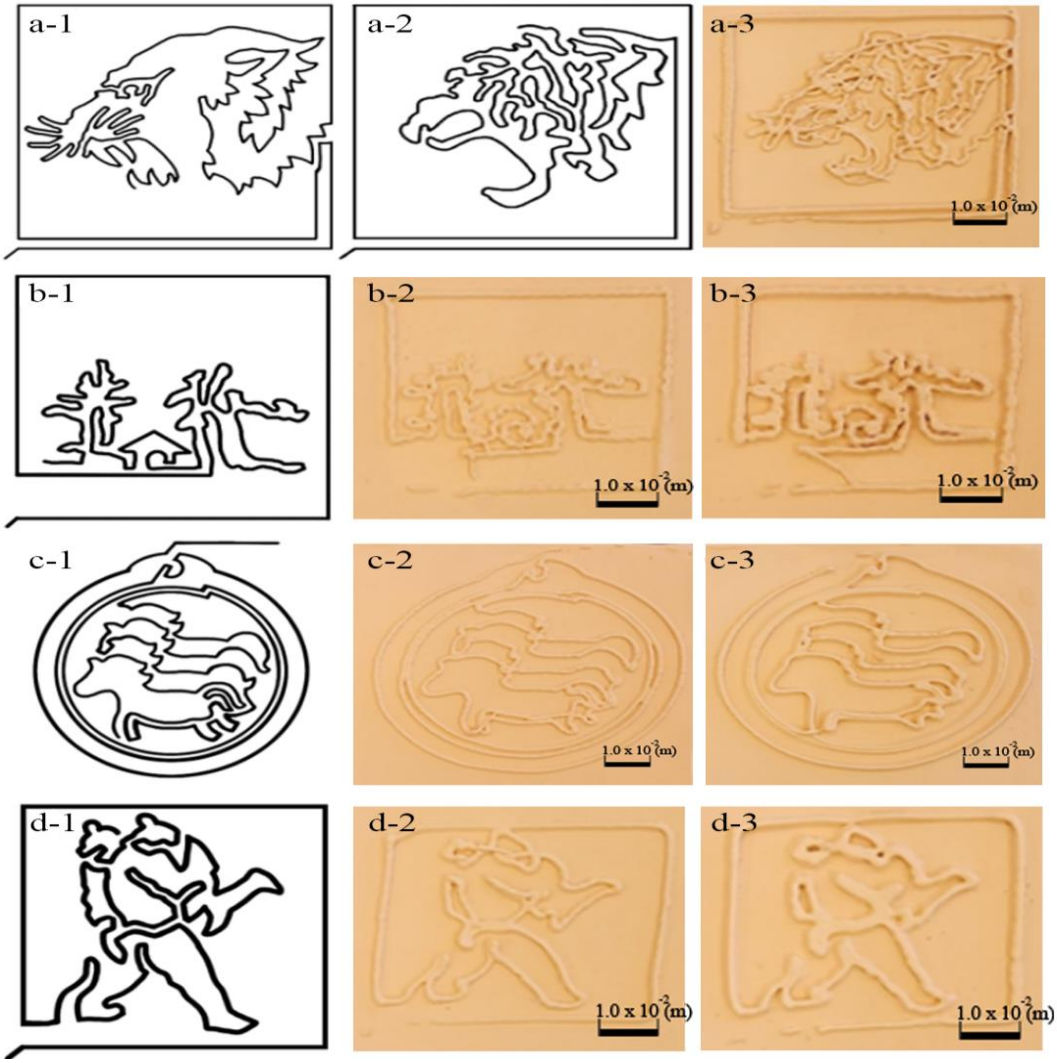

Figure 3. The design prepared on the web page and the final 3D printed works. a) Tiger; b) Sehando ; c) Mapae; d) Ssirum

3.2. Remote IoT controlled 3D Prinitng Education and Manufacturing

Even with an understanding of the background of the artwork, the intention was to reinterpret it from different eras and perspectives, portraying the artistic value that reflects the feelings of contemporary individuals unrelated to the circumstances of that time. Figure 4-a showcases the 3D printing results representing the seasonal changes in the artwork Sehando. It describes how the artwork captures the image of nature, represented by three pine trees and one fir tree, preserving loyalty and divinity despite the passage of time against the backdrop of a cold, snowy winter. The explanation also delves into Kim Jeong-hui 's exile experience, the political and social context, as well as the melancholy and isolation experienced by an individual in exile.

Using the original artwork as a backdrop and through conversations with students, Kim, the corresponding author of this paper, attempted a new approach to 3D printing, incorporating the resulting artwork in the following image. The backdrop aims to convey the interpretation that although Sehando represents the isolated life of someone living in a cold winter, it doesn't mean they always lead a lonely life in all seasons, including spring, summer, autumn, and winter. It expresses the idea that human loneliness and despair are but fleeting moments in the grand flow of time. In VIZO design, two different layers were printed, emphasizing the three-dimensionality predominantly with brighter colors and representing each season with suitable hues. The trees and the house were depicted in white during winter, while the trees in the other seasons were portrayed in shades of green. The second layer intended to represent yellow for spring, green for summer, and brown for autumn.

Figure 4. *(a) reinterpretation of Sehando; (a-1) Sehando's spring, (a-2) summer; (a-3) fall, and (a-4) winter*

In the author's new interpretation, the author reimagined and simplified Figure 5-a into four distinct designs: a-1, a-2, a-3, and a-4. Each design incorporates elements such as leaves, wisteria flowers, and butterflies, with different layers representing the changing seasons. Various colors of clay are utilized to portray these transitions.

On the first layer, brown clay is used to print leaves, symbolizing winter and fall, while turquoise clay represents spring and summer. Snow-covered wisteria flowers are depicted during autumn and winter. Additionally, butterflies are incorporated into the designs, serving as an idealized symbol of hope, even in seasons where they are not naturally present. In winter, white flowers and light blue butterflies depict the butterflies, while red butterflies are featured in summer, yellow butterflies in spring, and orange butterflies in fall. These butterflies are positioned on green wisteria flowers during seasons other than winter.

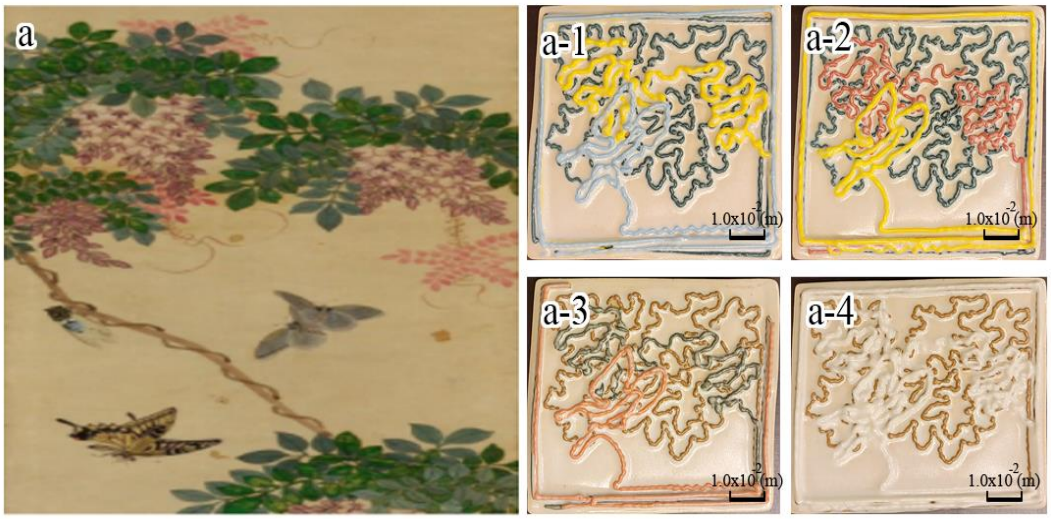

Figure 5. *(a) Hwajeopdo, reinterpretation of Hwajeopdo in (a-1) spring, (a-2) summer, (a-3) autumn, and (a-4) winter.*

3.3.Emotional products across time and space

Figure 6 showcases Kim Hong-do's Eight Bird Print (b), while the works on either side (a, c) represent scenes of drunkenness from Kim Hong-do's Pyongyang Thanksgiving Feast. The painting portrays a feast in Pyongyang and aims to convey the idea that people at that time could connect across social classes through the shared experience of alcohol during the festivities. The body of the intoxicated person is depicted in red, symbolizing the gradual effects of drunkenness. In Figure 6, a-1 and c-1 are enlargements of small sections from the larger painting, created by the author, Kim. Meanwhile, b-1 and b-2 in Figure 6 have been reinterpreted by the authors. They designed and represented Kim Hong-do's artwork, which depicts the lives of commoners alongside the aristocracy. By illustrating people in a state of drunkenness, they sought to portray a life that is free and unrestrained.

Each design is made available on the web, enabling both students and the general public to utilize various colors and materials through IoT-based 3D printing. This allows for the expression of the peaceful nature surrounding them. In Figure 6, b-2 is presented differently from b-1, offering a unique perspective on love and affection. The participant perceives the bird as a living artistic element and associates it with symbols of freedom, longing, and peace. By choosing appropriate colors, they create a distinct representation. In c-1 of Figure 6, a scientific technique was employed to print the red and white clay in different proportions. The first layer used a ratio of 3:7, the second layer had a ratio of 5:5, and the third layer had a ratio of 7:3. This gradual change in proportions aimed to visually represent the progression of intoxication. After receiving Kim's interpretation and explanation of the VIZO method, participants were encouraged to express their own emotions by modifying the design with their personal touch. They had the freedom to adjust the ratio of materials and the number of layers according to their creative vision.

Kim Hongdo's artwork can sometimes be challenging to comprehend, but the participants were motivated to create their own unique pieces by reinterpreting the historical and social context. Contemporary designers and beginners alike have reimagined and printed Kim Hongdo's works from different eras in their own distinctive ways. In Figure 6, corresponding author, Kim aimed to understand the meaning behind each piece, resulting in a final arrangement that portrays a person experiencing boundless freedom, akin to an intoxicated bird. Specifically, in B-1 of Figure 6, branches, leaves, and birds were strategically placed on three different levels to create a sense of depth and space. Above all, there was an attempt to establish connections or amplify the disconnections between different works by the same artist and reassemble them in a fresh and meaningful manner.

The uniqueness of this paper lies in the techniques and ideas employed to select a small portion of the Pyongyang Thanksgiving Feast painting, which has a total size of 71.2x196.6cm², and transform it. By

enlarging specific parts of the painting, the corresponding author, Kim, aimed to maximize and highlight the delicate sensitivity of the artist that is often overlooked in a larger painting. The objective was to honor and give life to the small, easily forgotten details through the fusion of science and art. The VIZO technique allows for the interpretation of art through the lens of personal experience, providing an approach that facilitates the creation of artworks with the intention of conveying the essence of freedom to oppressed individuals throughout history.

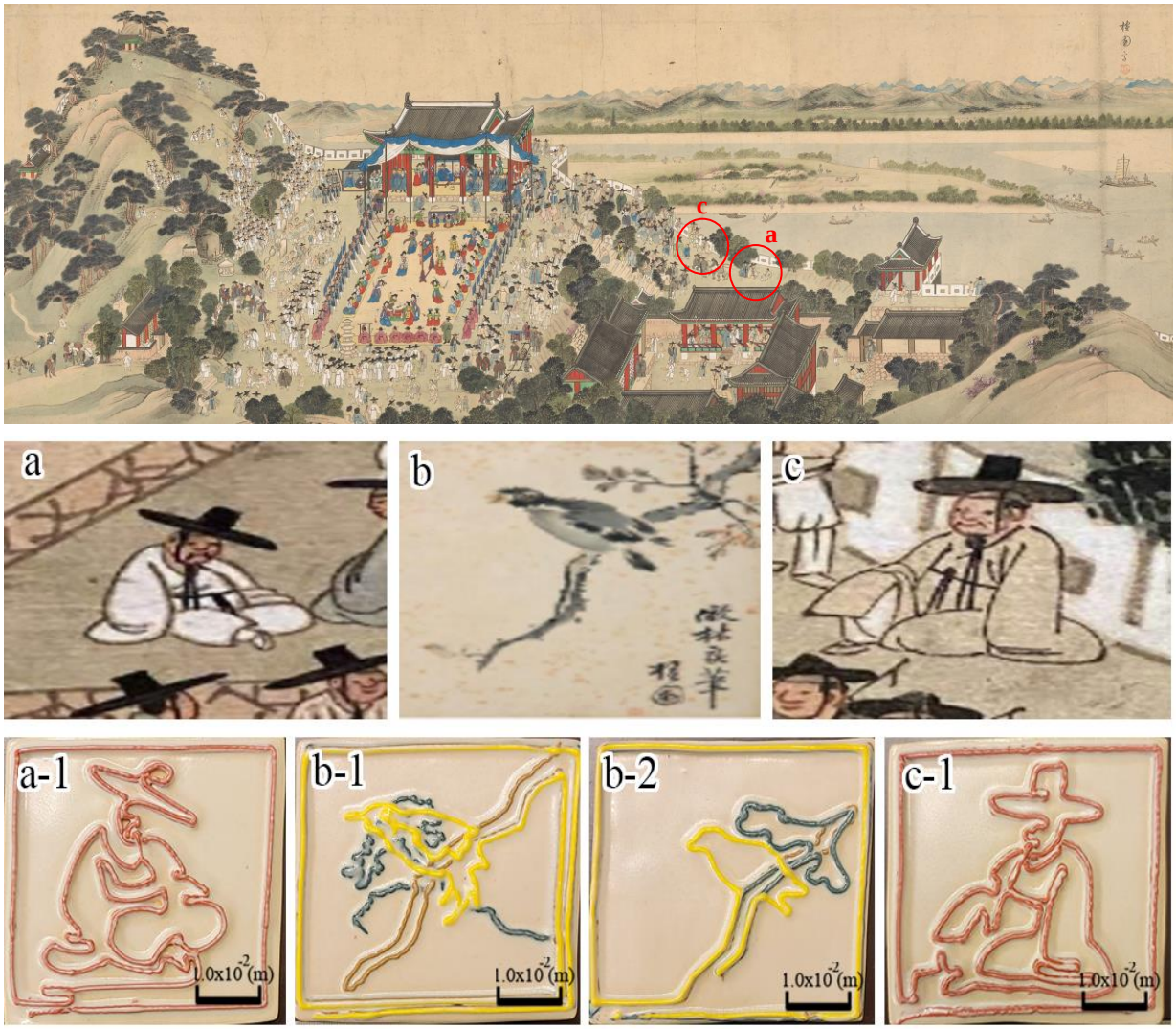

Figure 6. (a,c) Depict part of Kim Hong do's Pyongyang Thanksgiving Feast painting; (b) Kim Hong -do's Palgajo (Eight Birt Print); (a-1, c-1) Reinterpretation of Pyongyang Thanksgiving Feast painting, d runk man; (b-1) Reinterpretation of Palgajo; (b-2) Reinterpretation of Palgajo

Interestingly, among the trainees, there were foreign students with diverse cultural backgrounds and languages. Although they might not have fully related to the joys and pains of different cultures, they made an effort to express their own unique experiences. Through the creation and 3D printing of 2D, 2.5D, and 3D shapes, as well as the development and expression of their own designs, they were able to effectively nurture their personal artistic creativity. The original and reinterpreted 3D printing outcomes provided students with a fresh perspective on art education and deepened their understanding of artistic SM. By designing and 3D printing based on their own artistic ideas, students were able to effectively communicate their personal emotions and experiences using artistic SM technology, resulting in the creation of 3D artworks that blended engineering and artistic elements.

Many of the participating students expressed a desire to convey their emotions through the exploration of unconventional materials. Students experimented with a variety of unexpected substances, including chocolate, ice cream, yogurt, tofu, milk, ketchup, peanut butter, butter, hemp oil, hemp powder, artificial

rubber, chewing gum, and honey. Some students even proposed the idea of adding flavor to the ingredients. After years of teaching, Kim, the corresponding author, came to recognize that education is a dynamic fusion that connects educators and students, and she never felt redundant or stifled in any of the courses. As the curriculum progressed, students taught themselves about sliding inside the piston and how to maintain uniform moisture within the compound due to the unique properties of clay.

3.4. 3D Printed Product Merchandising Sustains Exclusivity

With the rise of virtual education services due to the impact of COVID-19, the use of IoT systems can provide a safe and sustainable solution for remote education. This has been particularly evident in the field of art, where the remote control of 3D printers has proven to be feasible. This approach can be applied to the traditional roll-to-roll method, allowing for the elimination of distance restrictions and mitigating the health and environmental risks associated with conventional FDM and resin 3D printers [17][18].

Through the VIZO Education Program, participants have developed the ability to express their emotions and gain confidence in artistic expression, even without formal artistic training. This program has demonstrated its educational effectiveness by utilizing IoT systems and has shown great potential in stimulating imagination and recreating the artistic value of VIZO designs. The program's achievements were recognized and featured in the university newspaper [19] The corresponding author, Kim, explained the VIZO method of emptying and filling, emphasizing the importance of avoiding excessive greed. This cautionary advice highlights the potential consequences of trying to fill one's artistic expression with too much ambition. For this innovative process, Kim received a patent. [20]

Figure 7 showcases ceramic products created through IoT-enabled printing, where designs were transmitted across borders. These creations have now been registered as non-fungible tokens (NFTs) and are available for sale as personal property. This collection exemplifies the utilization of VIZO designs and NFTs in the creation of ceramic artifacts with commercial potential. The featured items include: (a) wall hangings, (b) coffee mugs, (c) Pythagoras Cups, and (d) a tabletop display.

Figure 7. *Showcases ceramic crafts created using VIZO design and NFT, demonstrating the method of commercially selling these products by registering them as NFTs: (a) Wall hangings, (b) Coffee mugs, (c) Pythagoras Cups, (d) a tabletop display.*

3.5. Hemp Products: "Hempcrete"

The convergence of science, engineering, and literature with the arts has faced criticism from some quarters. However, there is a need for new and unconventional convergences centered around the arts to expand the boundaries of this concept. This study represents one such endeavor by exploring the utilization of hemp, a material that may not be readily available or recognized within legal frameworks, as a focal point for the convergence of art and science in the domains of education, business, and research.

Given the challenges posed by global warming, resource depletion, and environmental pollution, it has become increasingly important to prioritize the use of eco-friendly materials instead of chemicals to preserve the value and longevity of artworks. In this regard, there is a growing potential for employing

hempcrete as an eco-friendly and sustainable building material [21]. By embracing such alternatives, we can address environmental concerns while fostering artistic expression and innovation.

Hempcrete is an environmentally friendly building material created through a relatively straightforward process involving hemp stalks' cob husks, lime, and water. This material offers several advantages, including non-toxicity, excellent sound and shock absorption, and versatility in applications such as earthquake-resistant design. It also has the capacity to sequester carbon dioxide, undergoes continuous calcification as hemp and lime combine, gradually hardening over time. In comparison to traditional concrete, Hempcrete is lighter and environmentally friendly when disposed of. Notably, Hempcrete extends beyond its architectural applications and has found its way into the realm of art. To create artistic pieces, the process involves kneading hemp stalk cobs, lime, and water, allowing for complete drying before applying an earth-based lime plaster as a finishing touch. A distinctive characteristic of Hempcrete is its deliberate slow drying process, which can range from 24 hours to a month, depending on the size and climate conditions. If cracks occur during the finishing stages, they can be repaired, sanded, and coated with natural wood oil, honeycomb wax, or lacquer.

Song, the author, conducted experiments involving the addition of molding soil, diatomaceous earth, and natural resins to Hempcrete, each contributing distinct weights and textures to the material. The timing of hemp seeding also plays a role in determining the texture and weight, making Hempcrete adaptable for various applications. As a result, Hempcrete extends beyond its architectural uses and finds its way into the creation of diverse objects like furniture, lighting fixtures, and planters. Hand building molding, in particular, has emerged as an art form practiced by skilled professionals. However, legal restrictions have rendered hemp largely inaccessible to the general public for the past 60 years. These restrictions vary by region, time, and the prevailing laws of the land. Despite its potential benefits, the utilization of hemp has been limited due to these regulations, inhibiting widespread exploration of its artistic and practical applications.

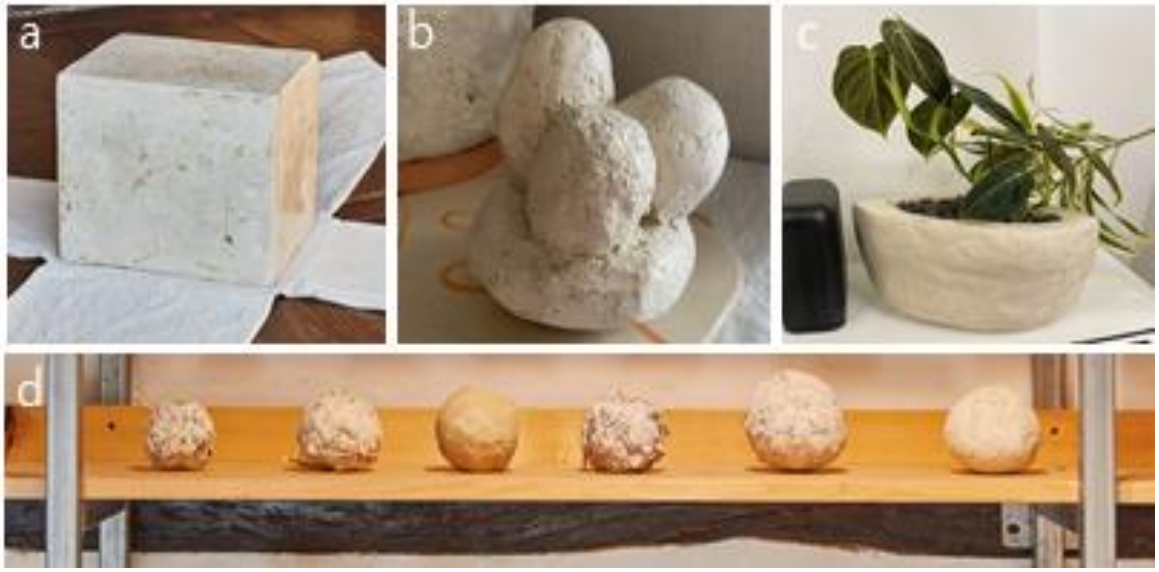

Figure 8. *Hempcrete masterpieces. (a) Pixel #1, 2022, hemp, lime, water, lime plaster, bee wax, natural plants oil, 25 x 30 x 30 cm; (b) Eggs 2023, hemp, lime, water, lime plaster, bee wax, natural plants oil 10 x 10 x 11 cm; (c) Eye pot 2023, hemp*

3.6. 3D Printed Hemp

When discussing the future of the hemp market, it's important to avoid exaggeration or distortion. Hemp has been utilized for over 3,000 years in the East, with only a 60-year ban in South Korea. Despite not being as well-known as flowers like forsythia or rhododendron, hemp is a plant that surrounds us in various forms [22].Hemp is unique in that it contains two components, cannabidiol (CBD) and tetrahydrocannabinol (THC), which have distinct effects. Flowers, leaves, stems, roots, seeds, and bark all

contain different concentrations of these components. CBD is known for its calming, sleep-inducing, and brain-soothing properties, while THC stimulates the brain in the opposite manner [23]. With the United Nations recommending the legalization of medical cannabis in 2020, it is anticipated that hemp will expand its usage from medical to edible applications in the future.

As we enter the post-COVID-19 era, significant changes are expected in the industry and workforce training. These changes may include permissible THC content, CBD deregulation, and advancements in extraction analysis techniques. Despite historical choices excluding hemp from essential areas of research, there have been creative educational endeavors that explore the possibilities of combining education, art, and the medical use of hemp. These attempts aim to bridge the gap and fill the void in research within this field. Catholic Sangji University and Andong Science College, located in the Andong Cannabis Special Economic Zone, collaborated to collect hemp stalks, roots, and other components through a legal process (Figure 9-a). This initiative represents a convergence of hemp-related laws, scientific analysis, regulatory science, and art. The collected materials were then processed to produce printable hemp lime, specifically for use in the field of art. To facilitate the safe 3D printing of this hemp material, an installation was set up at the VIZO Art Center (Figure 9-b).

At the VIZO Art Center, a successful mixture of hemp and gypsum was formulated in specific proportions, allowing for the creation of 3D printed artworks. Notable examples include a three-layered carnation (Figure 9-c) and a painting depicting Sehando (Figure 9-d). Significantly, participants in the training program were able to overcome issues of inaccessibility, distance, perception, or physical limitations by remotely sending images of their designs. This allowed them or a designated third party to design and produce the final product. Through this training, VIZO designs could be created from any location and transmitted via the web to the VIZO Art Center in Yecheon, Gyeongsangbuk-do. The reliable utilization of hemp stalks and roots ensured the successful printing of their unique designs.

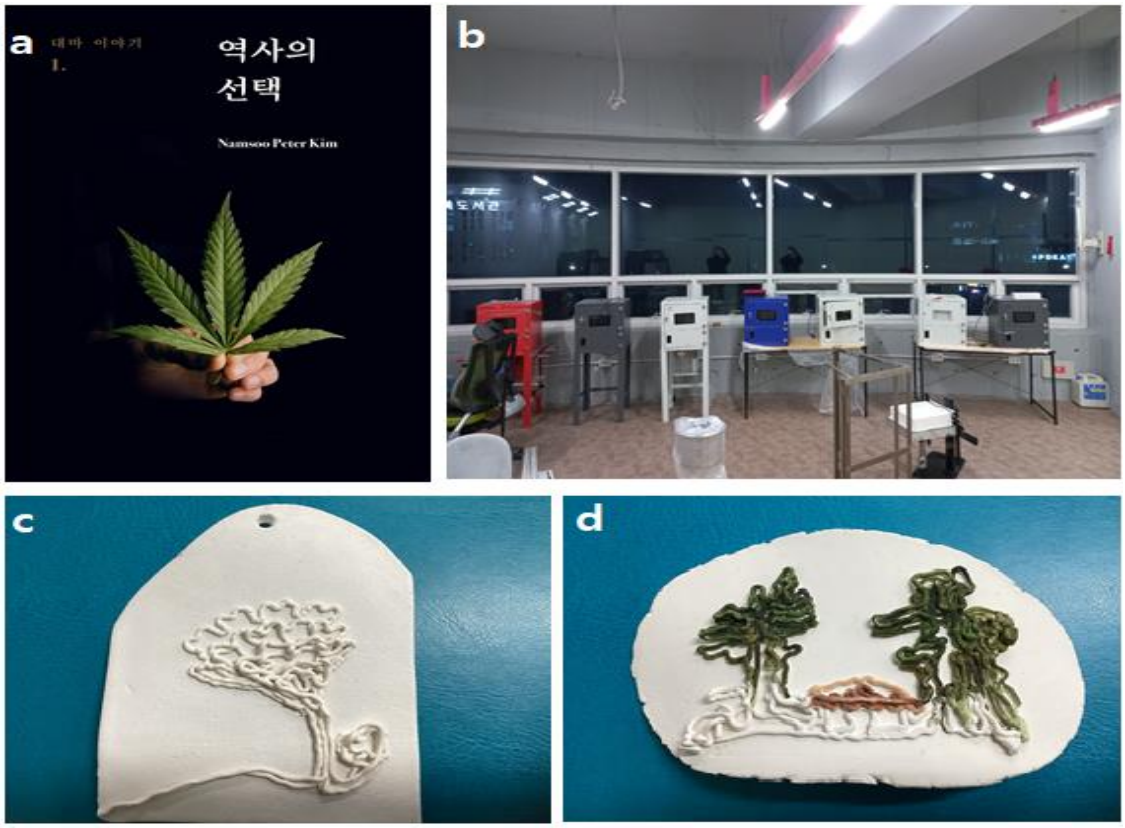

Figure 9. *Protocols, locations, and outputs of cannabis stems and roots processed for use in 3D VIZO art: a) Cover of a book describing protocols for non-contact cannabis processing; b) VIZO Art Center, located in Yechon, Gyeongsangbuk-do, where remote 3D printed; c) Three-layered carnations made with cannabis-infused lime; d) Two-tone 3D painted Cannabis Lime in different colors.*

4. Discussion

This paper focuses on several key aspects that warrant discussion: the effectiveness of the education, its relevance in the realm of art, the potential issue of plagiarism in reinterpreting existing works, and the user-friendliness of the equipment.

The effectiveness of the education: This aspect focuses on evaluating the effectiveness of the VIZO method as an educational approach. It considers the success of its implementation in educational settings and its ability to empower students with limited or no prior artistic training to produce their own creative works. The evaluation may include factors such as the comprehensiveness of the training sessions, the reinforcement of conceptual understanding, and the utilization of pre-generated designs to facilitate learning.

Relevance in the realm of art: This aspect examines the significance of the VIZO method within the field of art. It explores how the integration of traditional arts and modern technology, particularly ceramic 3D printing, contributes to the preservation of artistic originality and creativity. It also considers the potential application of VIZO techniques in various artistic domains and their ability to convey artistic inspiration authentically.

The potential issue of plagiarism in reinterpreting existing works: This aspect addresses the ethical concern surrounding the reinterpretation of existing artworks using the VIZO method. It discusses the importance of avoiding plagiarism and respecting intellectual property rights when reimagining and adapting existing masterpieces. This includes considering the responsible and creative ways in which reinterpretations can be done while acknowledging and honoring the original artists.

The user-friendliness of the equipment: This aspect evaluates the ease of use and accessibility of the equipment used in the VIZO method, particularly the IoT system-based 3D printer. It assesses how user-friendly the equipment is for participants with limited or no background in art and how well it enables them to translate their thoughts and images into 3D printed artworks within a reasonable timeframe. The evaluation may include factors such as user interface design, technical support, and overall user experience.

5. Conclusion

The integration of traditional art and modern science and technology has gained significant attention, particularly with the rise of distance education worldwide. In response to this trend, the 3D remote printing VIZO method has been developed and successfully applied in the field of science and art. Building upon ceramic 3D printing technology, the VIZO method has been implemented in educational settings in the United States and South Korea for over 12 years. It employs a unique approach that combines three-dimensional spatial drawing techniques, reminiscent of brush painting or external outline drawing methods, while preserving the originality and creativity of traditional art in a remote setting. Digital manufacturing (DM) leverages remote data transmission to move away from mass production and embrace small-scale, on-demand production. This allows for customized designs to be transmitted to manufacturing sites worldwide, facilitating on-site production. In the realm of arts, Artistic Smart Manufacturing has emerged to support artists. However, the fusion of engineering and art is essential for fostering interdisciplinary education. By integrating IoT-enabled equipment with appropriate printing materials, it becomes possible to create artworks that truly embody artistic inspiration. A balanced teaching approach that combines virtual classes and hands-on practice has been successfully implemented at institutions such as UTEP in the United States and Korea University, Seoul Biomedical 3D Printing, Yongsan Craft Center, Igu Craft, Gimhae Small Artisans Specialized Center, Pocheon Youth Center, and VIZO Art Center in Yecheon-gun, Gyeongsangbuk-do. This approach caters to individuals without formal artistic training or experience, enabling them to unleash their creative potential. Furthermore, the VIZO method has been successfully applied with local artists in Andong, using hemp materials, to explore the possibilities of the 3D VIZO method in combination with unique materials.

In the spring semester of 2021 to the fall semester of 2022, foreign students at Korea University engaged in artwork creation that conveyed design and emotion, aiming to transform their thoughts and

images into various VIZO 3D products in under 30 minutes. This highlights the potential of merging art and modern technology in traditional Korean crafts and indicates its extension to coffee latte art, 3D printed food art, and metalwork. Through educational programs that leverage the interdisciplinary strengths of science, engineering, and art, the delivery of personal memories and emotions to specific individuals via artwork or 3D-printable food, regardless of the material type, has been practically explored as an extension of the convergence concept. Furthermore, in the spring semester of 2023, collaboration took place in Andong, Gyeongsangbuk-do, where hemp research is legally permitted, with an artist specializing in small furniture and objects created using hemp. This collaboration confirmed the possibility of combining traditional art and modern technology through a construction technique called 'hempcrete' and resulted in artworks that conveyed the concept of natural decay. The harmonization of modern technology and traditional art forms has opened up new opportunities for creativity and self-expression.

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