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Araştırma Makalesi ● Research Article

The History and Future of Ceramic Sculpture: From Ancient Clay Figures to Modern 3D Printing

Seramik Heykelin Tarihi ve Geleceği: Antik Kil Figürlerden Modern 3D Baskıya

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ÖZ

Bu araştırma, seramik heykel sanatının tarihini ve geleceğini inceleyerek bu önemli sanat formunun gelişimini değerlendirmeyi amaçlamakta ve antik dönemden günümüze kadar olan süreçte seramik heykel sanatının rolünü ve değişen yüzünü gözlemleyerek gelecekteki potansiyelini tartışmaktadır. Araştırma, antik dönemde seramik heykellerin dini ve mitolojik ifadeler için kullanıldığını ortaya koymaktadır. Antik Mısır, Antik Yunan ve Roma İmparatorluğu gibi medeniyetler, seramik heykeller aracılığıyla inançlarını ve kültürlerini yansıtmıştır. Orta Çağ ve Rönesans dönemlerinde, seramik heykeller estetik ve dini amaçlar için üretilmiş, kilisenin iç dekorasyonunu zenginleştirmiştir. Bu dönemlere ait heykeller, geleneksel el işçiliği ve el yapımı tekniklerle öne çıkmaktadır. Modern dönemle birlikte, teknolojik gelişmeler seramik heykel sanatını kökten değiştirmiştir. Seramik heykellerin sanatsal ifadelerinde çeşitlilik ve değişim gözlenmiş, sanatçılar toplumsal, politik ve çevresel konuları ele alarak yeni ve çağdaş eserler üretmişlerdir. Seramik sanatının teknolojiyle olan ilişkisi, son zamanlarda artarak devam etmektedir. Özellikle 3D baskı teknolojisi, sanatçılara daha fazla yaratıcı özgürlük sunmuş ve heykellerin daha karmaşık formlarının ve detaylarının oluşturulmasına imkân vermiştir. Seramik heykel sanatı, kültürel mirasımızın önemli bir parçası olarak varlığını sürdürmekle birlikte sanatçılar gelecekte seramik heykeller aracılığıyla insanların düşünce yapısını ve toplumsal bilincini şekillendirmeye devam edecektir. Bu sanat formu, tarih boyunca evrilen ve değişen bir ifade biçimi olarak gelecekte de teknolojinin getirdiği kolaylıklarla birlikte sanatçıların yaratıcılığını ve ifade özgürlüğünü temsil ederek insanların sanatsal deneyimlerini artırmayı sürdürecektir.

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ABSTRACT

This research aims to examine the history and future of ceramic sculpture, evaluating the development of this significant art form. It observes the role and evolving face of ceramic sculpture art from ancient times to the present, discussing its potential in the future. In ancient times, people used ceramic sculptures to express their religious and mythological beliefs. Civilizations such as Ancient Egypt, Ancient Greece, and the Roman Empire reflected their beliefs and cultures through ceramic sculptures. During the Middle Ages and Renaissance periods, artisans produced ceramic sculptures to enhance the aesthetic and religious aspects of churches' interior decoration. The sculptures from these periods stood out for their traditional craftsmanship and handmade techniques. With the onset of the modern era, technological advancements have fundamentally transformed ceramic sculpture art. Artists have observed diversity and change in the artistic expressions of ceramic sculptures as they address societal, political, and environmental issues, creating new and contemporary works. The relationship between ceramic art and technology has continued to grow, especially with the recent advancements in 3D printing technology, which provide artists with greater creative freedom and allow for the creation of more complex forms and details in sculptures. While ceramic sculpture art remains an essential part of our cultural heritage, artists will continue to shape the thoughts and societal consciousness of people through ceramic sculptures in the future. As a form of art that has evolved throughout history, ceramic sculpture art will persist in representing the creativity and freedom of expression of artists, enhancing the artistic experiences of individuals with the conveniences brought about by technology.

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Introduction

Throughout the course of history, art has played a pivotal role as a crucial instrument for human groups to effectively convey their emotional, cultural, and aesthetic encounters. The notion in question is of great significance as it aids individuals in the process of harmonizing their connection with both society and the environment. This concept has persisted through a time period that encompasses ancient times to the present (Fischer, 1990, p. 5). Humanity has evolved, altered, and learned throughout history. This has also applied to art, as basic materials have changed throughout time to create works of art. Artists have used stone, marble, and ceramics to create sculptures, and they have assessed each material independently.

Ceramic sculptures have conveyed ideas about communication, mythology, and religion since ancient times. In addition, these sculptures offer valuable insights into the historical context of the eras in which they were created. Throughout history, civilizations have sought after clay as a medium for sculpting due to its ease of acquisition from nature, malleability, and ability to rectify mistakes compared to materials like stone and marble. As a result, throughout history, civilizations have employed clay for sculpting in addition to making pottery. Even today, artists continue to create sculptures using clay, and technical advancements have propelled this art form forward. Especially the 3D printing of models created with the help of computer-aided designs has made it easier for ceramic artists to work in their fields, and the difficult forms have become easily uncovered.

The primary focus of this research is to examine the evolution of ceramic sculptures throughout history, explore the changes introduced by 3D ceramic printing technology in the process, and assess the impact of this technology on ceramic shaping production. The main idea here is to focus on the historical transformation of ceramic sculpture by shining light on the future of contemporary ceramic art. Furthermore, researchers have examined how ceramic sculptures shaped using technology can potentially impact society and culture. The continued development of technology is an indication that the use of 3D printing in ceramic sculpture production is going to reach further levels, thereby leading to transformations in the artistic field in the near future.

The research aims to explore the history of ceramic sculpture and establish a foundational framework for contemporary ceramic sculpture art, seeking to understand the innovations and opportunities that 3D ceramic printing technology can bring to the art field in the future. The research into the historical production process of ceramic sculpture and its artistic significance provides a foundation for future studies. The development of ceramic sculpture with the support of technology can have a significant impact on the artistic perspective in many ways, as it provides some advantages in terms of production and can ultimately lead to creative products beyond expectations. This research focuses on the historical development of ceramic sculpture production, examines production methods together with current techniques, and creates infrastructure for future research. The research includes a literature review on ceramic sculpture, an examination of the use and development of ceramic sculpture throughout history, and a discussion of the effects of ceramic sculpture production using technology on sculpture art. Research findings support these methods in understanding the history of ceramic sculpture and its evolution into a production form in the future.

History of Ceramic Sculpture

Ceramic sculpture art has played an important historical role as a primitive form of culture, mythology, and human artistic expression since ancient times. Ceramics is used to produce items that meet daily needs. It is obtained by firing clay after it dries, and the same method is followed when making ceramic sculptures. This durable and malleable material has

gained immense popularity amongst ceramicists and sculptors (Morito, 2022, p. IX). Ceramic sculptures have served as ritual instruments in religious ceremonies and have been designed as aesthetic expressions or integral aspects of everyday living. Throughout the historical process, ceramic sculpture has continuously progressed with shifting techniques, themes, and forms in a multitude of historical eras and cultures. In this research, the development of ceramic sculpture will be examined through Ancient Ceramic Sculptures, Medieval and Renaissance Ceramic Sculptures, Modern Era Ceramic Sculptures, and Ceramic Sculptures of Contemporary Ceramic Art. It is crucial to understand the distinct features and importance of ceramic sculptures within these epochs to trace the advancement of this art form.

Ancient Ceramic Sculptures

Ancient earthenware sculptures are considered to be among the earliest forms of artistic expression in human history, playing a significant role in the cultural heritage of major civilizations that span from Ancient Egypt to Ancient Greece and the Roman Empire. Remarkable pieces of art from antiquity include Etruscan sculptures from the late 6th century, the iconic Sarcophagus of the Spouses, Greek Tanagra figurines, and the renowned Chinese Terracotta Army from the late 3rd century BCE. These fired clay sculptures depict the perpetuating heritage of numerous distinguished sculptors throughout history, including Michelangelo, Bernini, Canova, Rodin, Brancusi, Noguchi, Moore, and Picasso (Morito, 2022, p. 3). Across eras, ceramic sculptures have served a diverse array of purposes, ranging from religious and aesthetic to monumental, and have transformed into symbolic representations of the artistic and cultural legacy of their corresponding epochs.

Ceramic Sculptures in Ancient Egypt

Ceramic sculptures played a significant role in the religious and ritual practices of Ancient Egypt. The representations of mythological characters of the era, shaped in three dimensions with ceramic clay, have formed the visual form of grammar and communication. They often portrayed gods, goddesses, and notable individuals. A distinguishing feature of Egyptian ceramic sculptures was the utilization of stylized and geometric designs, providing valuable insights into Egypt's religious beliefs and way of life. Fired clay sculptures from this period are quite rare, but Egyptians typically created them as offerings.

A noteworthy specimen is a ceramic goddess figurine that follows the Ansyromene style. It portrays deities in an Egyptian stance, with plant crowns embellishing their heads. The hairstyle, originating from Libya, intertwines artistic details from both the Egyptian goddess Isis and the Greek goddess Aphrodite, such as wrist and ankle bracelets along with shells on the back of the head (Figure 1). This statuette, similar to others of its genre, portrays a naked form and features a neck structure that denotes a fusion of Egyptian and Greek elements (Kabil, 2022, p. 195). The integration of fired clay sculptures into Egyptian art blended traditional sculptural styles from Egypt with those influenced by Roman and Greek art. These figurines, made of fired clay, range from the late 4th century BC to the Byzantine era and are noteworthy due to their striking diversity in subject matter, extending beyond the cultural context to include daily life scenes (Figure 2) (Szymańska, 2011, p. 451). In subsequent eras, one can perceive alterations and a broadening array of sculptural configurations under the evocative impact of Roman aesthetic conventions.

Figure 1: Statue of the goddess Isis-Aphrodite Tanta Museum, (Kabil, 2022, p. 205).

Figure 2: Helmeted Athena from Tell Atrib, front and side view (Szymańska, 2011, p. 452).

Ceramic Sculptures in Ancient Greece

Ceramic sculptures in ancient Greece were distinguished as manifestations of aesthetics and religion (Figure 3). As early as the 9th century BC, and possibly even during the time when Hesiod narrated the misogynistic story of Pandora's creation, artists in ancient Greece used Greek clay to depict human figures. During this early period, people shaped certain figurines of fertility goddesses by hand and left them to dry in the sun, representing both fertility and worship of the goddess (Barr-Sharrar, 1993, p. 30). Greek ceramic sculptures depicted mythological figures and daily life (Figure 4). People offered fired clay figurines in temples and as grave offerings. People extensively used fired clay figurines in religious practices and to decorate a variety of items, from small sculptures to monumental art and private furniture, particularly in Southern Italy (Kingsley, 1976, p. 3). From the Archaic to the Hellenistic periods, the design and meaning of ceramics underwent significant evolution. Greek ceramic sculptures represent the artistic richness and cultural heritage of their respective eras.

Figure 3: A statuette of a mourning woman found in Thera (Sellada cemetery excavation) in 1896, in the last quarter of the 7th century BC, (Barr-Sharrar, 1993, p. 36).

Figure 4: Vase in the form of a kneeling child, ca. 540-530 BC, Agol-a Museum, (Barr-Sharrar, 1993, p. 37).

Ancient Roman Ceramic Sculptures

Before the rise of the Roman Empire, the Etruscans held a dominant position in the region, characterized by their highly refined artistic sensibilities. Latin writers were vocal in their appreciation of terracotta sculptures from Etruria (Figure 5). During the late 6th and early 5th centuries, Etruria experienced a pinnacle in terracotta sculpture production and governed over Rome (Richter, 1937, p. 5). However, the decline of the Etruscans paved the way for the Roman Empire to uphold the practice of creating terracotta sculptures. During Roman rule, artisans fashioned ceramics in several styles and subjects. Roman ceramic sculptures showcased an extensive array of portrayals, from classical mythology to everyday situations. Roman artisans produced terracotta figures during the Roman epoch for both domestic consumption and commerce. During the 2nd century BC and the 3rd century AD, Roman artisans exported terracotta sculptures to India (Figure 6). Artisans also produced local terracotta figurines during the same time, catering to the preferences of local patrons. Indian consumers particularly admired the sheen of Roman-manufactured terracotta products (Terra Sigillata) (Ghosh, 2021, p. 2). These sculptures represent significant works that demonstrate the diversity and richness of the vast expanse of the Roman Empire.

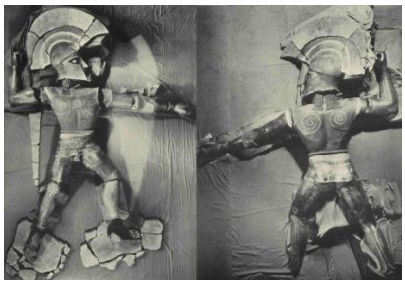

Figure 5: Terracotta Etruscan warriors (Richter, 1937, p. 34).

Figure 6: Terracotta head, Yeleswaram, Satavahana period (Ghosh, 2021, p.5).

Ceramic Sculptures of Ancient Mesopotamia

Throughout history, Mesopotamia has been the home of many great civilizations that have created remarkable ceramic sculptures. Notably, the Sumerians, Babylonians, and Assyrians were among the civilizations in Mesopotamia that produced significant works in this field. One enduring and primary purpose of Ancient Near Eastern art was to depict the connection between the earthly and divine spheres, inspired by primarily spiritual, religious, or political matters (Benzel et al., 2010, p. 9).

Sumerian sculptors possessed exceptional ability in carving figures on steles, tablets, vases, and bowls, often using abstract and impressionistic styles that displayed their sculptural prowess (Figure 7) (Kramer, 1963, p. 99). As one of the oldest civilizations in Mesopotamia, the Sumerians crafted ceramic sculptures principally for religious purposes. These Sumerian ceramic sculptures represented deities, goddesses, and diverse rituals. The ceramic figurines uncovered in Sumerian artifacts and temples provide significant revelations into the cultural practices and beliefs of ancient times.

The Assyrians, a powerful civilization that governed northern Mesopotamia, have left a significant artistic legacy. Palace art, increasingly portraying the royal image in detail and magnificence over the course of three centuries of the Assyrian Empire, served as a representation of the iconography of power. This art form became a highly influential force, leaving its imprint on the art of neighboring populations in both the East and West. Neighboring cultures often integrated Assyrian artistic elements into their own monuments (Benzel et al., 2010, p. 19). Assyrian ceramic sculptures displayed depictions of warfare, royal figures, and symbols including lions (Figure 8) to accentuate the military prowess and authority of the Assyrian Empire.

The Babylonians, a noteworthy civilization in Mesopotamia, contributed greatly to the growth of ceramic sculptures. Their ceramics frequently exhibited representations of their kings, gods, and mythological scenes; these sculptures are crucial masterpieces reflecting the might and prosperity of the Babylonian Empire. Despite the Babylonian government's brief existence, the city of Babylon was pivotal in colossal construction ventures. During the sixth century B.C., the Babylonian government adorned projects like the Ishtar Gate and the adjacent

Processional Way with brightly colored glazed bricks, which featured depictions of bulls, lions, and dragons (Figure 9) (Benzel et al., 2010, p. 14).

Figure 7: Sumerian sculpture of a seated couple representing domestic life and a loving marriage (Kramer, 1963, p. 160).

Figure 8: Lion head. Mesopotamia, Old Babylonian period, ca. 2000-1600 BC (Benzel vd., 2010, p. 14).

Figure 9: In the sixth century B.C., molded and glazed brick, Babylonian walking lion figure, (Benzel vd., 2010, p. 97).

Ancient Chinese Ceramic Sculptures

China is widely known for its exceptional expertise in ceramic production and has utilized various methods to create ceramics for diverse purposes throughout different historical periods. This region has continuously supplied an abundance of raw materials for ceramic manufacturing. Chinese ceramics comprise a broad spectrum, ranging from handcrafted pottery vessels fired in kilns to intricately designed porcelain items created for imperial palaces (Figure 10). Besides that, they also include construction materials like bricks and tiles (Akhond, 2019, p. 13). During a time when decorative pieces showcasing underglaze painting and glazing were widespread, objects of decoration, particularly from the Ming Dynasty, are notable. The

construction of the colossal mausoleum complex of Qin Shihuang, the first emperor of China, began in 247 B.C. and took 40 years to complete, and the Terracotta Army (Figure 11) is one of the most celebrated examples of ceramic sculpture in Chinese culture. The Terracotta Army consists of about 7,000 individual pieces crafted in Shaanxi Province and is truly a remarkable remnant of ceramic sculpture. The warriors, generals, and horses, crafted from life-sized ceramics and armed with real weapons, are arranged in a battle formation within three subterranean pits (Quinn et al., 2017, p. 96).

Figure 10: Ming Dynasty period glazed ceramic Buddha statue (Akhond, 2019, p. 13).

Figure 11: Terracotta warrior statues, Qin Shihuang's mausoleum complex, the 250s B.C. (Quinn et al., 2017, p. 968).

Medieval and Renaissance Ceramic Sculptures

The medieval and Renaissance eras were pivotal in European history, marked by major shifts in art and culture. Artists during this time created and advanced ceramic sculptures as fundamental features of religious, aesthetic, and cultural expression. The Middle Ages constituted a critical historical period spanning from the 5th to the 15th centuries and brought about remarkable developments in the field of art. Ceramic production in the Middle Ages focused primarily on religious purposes. When examined from a European perspective, stagnation in ceramic production during the Middle Ages is evident. Cooking vessels were commonly unglazed, but there were also some manufacturers of glazed vessels, pitchers, and fine ceramics. Local production experienced an interruption from the mid-11th century to the late 11th century, but it resumed at the beginning of the 12th century. During this period, people commonly used ceramic forms such as pitchers, cooking pots, and bowls (Young et al., 2005, p. 132). During the same period, the East and the Middle East employed advanced ceramic

examples. The ceramics uncovered in the city of Rey, Iran, from the Middle Ages exhibit a range of designs associated with Islamic culture that was prevalent in the Middle East and also reflected traditional Iranian practices (Figure 12). The collection comprises simple vessels used for cooking as well as opulent ceramics (Treptow and Whitcomb, 2007, pp. 11–12).

Figure 12: 1200s, turquoise glazed elephant figure, Iran (https://l24.im/hI3e).

The Renaissance extended from the late Middle Ages until the mid-16th century and constituted a noteworthy revival in the artistic realm. Artists in the Renaissance era distinguished ceramic sculptures by rediscovering and reinterpreting ancient Roman and Greek art. Italy's strategic location in the Mediterranean basin had a significant effect on the advancement of ceramic production and the emergence of the Renaissance in Italy. During the antique era, from the 9th to the 8th centuries BC, the Greeks and, from the 7th to the 5th centuries BC, the Etruscans created ceramics in this area. Italy's geographical location, in the core of a region that was in contact with a plethora of cultural influences, along with the high technical ability, visual appeal, and heterogeneity of ceramics, played a vital role. Additionally, elements from Byzantine, Islamic, and North African cultures had influence (Hess, 2002, p. 1). Renaissance ceramic sculptures have emerged as emblems of creative liberation and aesthetic greatness (Figure 13). In contrast to the Middle Ages, ceramics from the Renaissance possess an expansive range of connotations, exhibiting the artistic and aesthetic opulence of this epoch.

Figure 13: Bust of Christ, (artist unknown). Modelled 370-570 years ago, (Hess, 2002, p. 97).

Modern Period Ceramic Sculptures

The modern era denotes a time of groundbreaking developments in the art industry. Artists recast ceramic sculptures through contemporary expressions and novel methodologies while upholding their conventional shapes. The modern era extends from the late 19th century

to the mid-20th century in the art world. Artists renounced traditional methods and pursued pioneering approaches. Throughout this duration, ceramic art underwent considerable metamorphoses.

Towards the close of the 19th century, ceramic art underwent a considerable transformation due to the influence of the Art Nouveau and Art Deco movements. Art Nouveau is widely acknowledged for its characteristic organic shapes, nature-themed patterns (Figure 14), and usage of ceramics with glazing, while Art Deco relied on abstract and geometric designs. The technological and societal changes in the late 19th century gave the artists a wide range of inspiration from different artistic styles, laying the foundation for the Art Nouveau movement and allowing them to establish the fundamentals of industrial design while creating their works (Turan, 2017, p. 2). Artists frequently incorporated the aesthetic sensibilities of these movements into ceramic sculptures, which were used in vases, sculptures, and ornamentation (Figure 15). Artists transformed ceramic sculpture forms influenced by various art movements, including Art Nouveau, Art Deco, and the Bauhaus School, all associated with the Arts & Crafts Movement, which was widely spread across Europe (Figure 16) (Aslan, 2014, p. 16). In the early 20th century, abstract art movements also made an impact on ceramic art. Artists started to use the pliability of clay in ceramic sculptures to express their feelings, ideas, and abstract concepts. The ceramic sculptures from this era serve as a reflection of formal experimentation and abstract narratives (Figure 17).

Figure 14: Hugo Lonitz, Neuhaldensleben Jay, c. 1885, sitting on an oak tree with acorns. H. 44 cm. Earthenware, polychrome glaze, (Quittenbaum, 2022, p. 114).

Figure 15: Eduard Klablen 'Lady standing with fur', 1913/14, H. 36 cm. Execution: Langenzersdorf ceramics. Earthenware, polychrome glaze, (Quittenbaum, 2022, p. 111).

Figure 16: Young lady with a headscarf, c. 1905, H. 39 cm. Made by Friedrich Goldscheider, Vienna. Earthenware, dark and gold glaze, imitating bronze, (Quittenbaum, 2022, p. 107).

Figure 17: Gudrun Baudisch Lamp base, 1928, H. 33 cm. Execution: Wiener Werkstätte. Majolica, polychrome glaze, brass and porcelain mounting, (Quittenbaum, 2022, p. 121).

Contemporary Ceramic Art and Technology

Towards the end of the 19th century, the adoption of the Arts and Crafts movement by ceramic artists paved the way for the development of contemporary ceramic art. Theorists such as John Ruskin and designer William Morris adopted a critical approach, rejecting the impact of the Industrial Revolution on society and aesthetic values and emphasizing the importance of craftsmanship. Born in England at the beginning of the 20th century and raised in the Far East, Bernard Leach learned pottery in Tokyo. In 1920, he established his own ceramic studio in England, influencing ceramic art with a philosophy of craftsmanship and a perspective that regarded Japanese potters as artists; this had a significant impact on ceramic art, inspiring the creation of a new form of ceramic art that broke away from traditional structures after World War II (Adlin, 1998, p. 3). When examining the first examples believed to belong to contemporary ceramic art created by ceramists, one can observe that the ceramics maintained their functional features but evolved over time to take on more complex forms with developing design characteristics.

Pablo Picasso, Joan Miró, and Marc Chagall (Figure 18), among other modern-era artists, using ceramics as an artistic medium, contributed to the artistic development of ceramics, as stated by Havasi (2020), and during this period of modernism, characterized by advancements and changes in various scientific fields, artistic production departed from traditional and classical conventions, giving rise to new forms of expression and the emergence of contemporary art movements across different art disciplines, which influenced and developed in tandem with each other (p. 120). These artists, with their distinct approaches, not only opened new horizons in ceramic art but also made significant contributions to the evolution of contemporary ceramics. They challenged the traditional boundaries of ceramics by considering clay as an equivalent material to sculpture materials such as metal, stone, or wood, thereby expanding the expressive power of ceramic art (Adlin, 1998, p. 5). Adlin further asserts that Voulkos, among all pioneers of contemporary ceramics, had the deepest and widest impact, as his focus on vessel forms brought an entirely new meaning to ceramic art (Figure 19). Artists inspired by Voulkos's teachings continue to explore innovative ways of utilizing clay (Figure 20).

Figure 18: Marc Chagall, Sculpted Vase, 1952, Ceramic, engraved with a knife, oxides and glaze with a brush,114.3 cm, (Artsy, 2023).

Figure 19: Peter Voulkos. Bottle, 1961. Stoneware, (45.7 x 24.1 cm), (Adlin, 1998, p. 43).

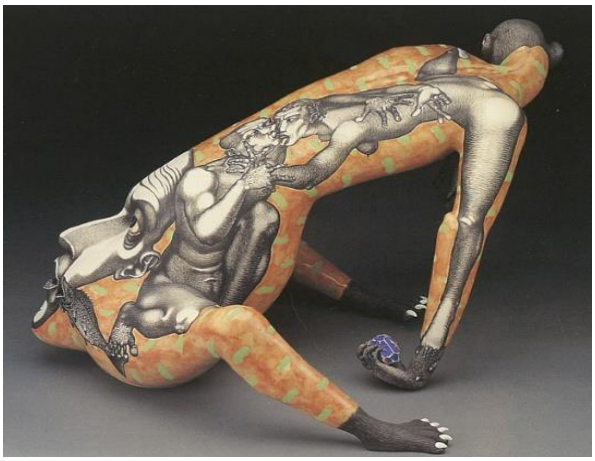

Figure 20: Sergei Isupov, Above Protection, 1999, 25x40x33 cm, Ferrin Galery, USA, (Yıldırım and Çınar, 2022, p. 73).

Since the latter part of the 20th century, there has been a notable increase in the diversity and integration of ceramic art with technology. Artisans have incorporated novel materials and methodologies to enhance conventional ceramic manufacturing procedures. Art, in tandem with the modernist movement, has undertaken a process of dismantling conventional frameworks, embracing novelty and flexibility, and continuously growing, developing, and diversifying due to the impact of technology. The coexistence of this dual connection has brought about significant changes in several areas within the field of visual arts (Kaya, 2023, p. 3).

The rapid development of technology has also impacted the field of ceramics. Industrial ceramics production utilizes computer-aided design (CAD) and computer-aided manufacturing (CAM) throughout all stages, from design to printing. Additionally, the printing of digital models using 3D printers can be considered a distinct stage in the production of sculptures for ceramic artists. Technology-assisted ceramic production has emerged as a new technique for artists, enabling them to easily shape complex figures that would be difficult and time-consuming to shape by hand. Artists first model the ceramic sculptures using design software that is compatible with 3D printers. A computer-controlled printer then prints the designed model in layers. The process involves deconstructing the data into flattened data and using a print head to execute layer-by-layer production using powders or other technologies (Zhu and Liu, 2023, p. 1). Based on these digital models, 3D printers build ceramic material layer by layer, achieving details and precision that were previously unattainable (Figure 21). A needle rapidly moves through a fully material-filled interior to create the cross-sectional shape of a workpiece. Transmitting data along the X-Y axis from the computer achieves this. Continuous sliding in Z-axis coordinates forms the integrated 3D print (Zhao, 2021, p. 2).

Figure 21: A 3d ceramic printer in operation and the resulting ceramic product, (Zhong et al., 2020, pp. 113-114).

Traditional ceramic production methods have inherent disadvantages. The conventional process requires a high level of intricacy, and 2D designs may not effectively communicate all aspects of production (Zhao, 2021, p. 1). It is crucial to consider both the time and financial costs associated with the ceramic artwork shaping process. Due to the critical evaluation of aspects within ceramic art production, individuals have integrated three-dimensional models into ceramic production utilizing 3D printers. Nevertheless, ceramic production through the use of 3D printers also poses challenges. Although it has advantages in advancing ceramic product design, the precision of three-dimensional models may not always meet expectations, and production times can be longer (Zhao, 2021, p. 1). Furthermore, it is imperative to assess the training and education regime involved in operating software programs and printer equipment for product modeling. This should incorporate an evaluation of proficiency with these tools. The decision to use conventional approaches or to use a 3D ceramic printer can depend on the designer's artistic approach and the design's characteristics.

Although both traditional handcrafting and ceramic shaping methods using 3D printers have their advantages and disadvantages, ceramic 3D printing technology enables the rapid production of intricate shapes and structural features. This facilitates the realization of designs with complexities that traditional modeling techniques cannot achieve (Figure 15). The fusion of 3D printing and digital technology enables designers to tackle the difficulties encountered in ceramic sculpture design. This reduces their workload, boosts work efficiency, and frees them from difficult and complex design and production procedures (Zhu and Liu, 2023, p. 6).

Recent technological advancements, such as 3D printers, have paralleled the changes in the artistic field following the Industrial Revolution, impacting the development of contemporary ceramic art and leading to new developments in the realm of art. Olivier van Herpt, as one of the artists utilizing 3D ceramic printers, defines industry as a machine and perceives it as a black box between designers and users. However, rather than separating his works from this machine, Olivier van Herpt transforms it into a platform for creative exploration (Figure 22). Olivier van Herpt transforms the machine into a platform for creative exploration, shaping ceramics that appear to be crafted by human hands but exhibit random imperfections, redefining human texture through the intervention of machines (Olivier van Herpt, 2023).

Figure 22: Porcelain flower pyramid, the pieces that complement the base of the flower pyramid shaped with ceramic 3d ceramic printer by Dutch designer Olivier van Herpt, (Zhao, 2021, p. 6).

Emre Can, another artist engaged in ceramic production using 3D ceramic printers, expresses that nature has instinctively influenced him and stirred his emotions. However, despite the inherently organic nature of the natural world, he emphasizes that digital media is highly artificial. Emre Can captures the contrast between artificiality and organic elements by deforming ceramics produced by machines, thereby bringing forth new forms (Figure 23). In doing so, the artist establishes his own system (Emre Can, 2023).

Figure 23: Emre Can, abstract sculpture, 3D printed porcelain, (Emre Can, 2023).

Traditional handmade methods have richly linked the history of ceramic sculpture. However, the field is now experiencing a paradigm shift, primarily due to technological advancements. In addition to nanocomposite materials, different plastic and metal powder mixes have been used in investigations with 3D ceramic printers, and new ceramic shapes have emerged as a result of ceramic artists embracing these new possibilities as an alternative shaping technique (Özgüven, 2015, p. 174). These changes are altering the landscape of ceramic sculpture, with a significant impact on its future. Of particular note is the resemblance between 3D printing technology and sculpture art in terms of materials and the possibility of future integration and development. Emphasizing the significance of materials in both 3D printing processes and sculpture art, it suggests a future where 3D printing technology could enhance the complexities of sculpture creation and increase efficiency (Liu, 2019, p. 294).

The future of ceramic sculpture will be significantly impacted by technological advancements. They have the potential to give artists greater freedom of expression and heightened creativity while simultaneously providing audiences with fresh and captivating experiences. 3D printers can expand ceramic art and manufacturing methods (Martinez and Can, 2016, p. 13). The incorporation of technology into ceramic sculpture has the potential to enhance the allure and ongoing development of this artistic medium.

Contemporary ceramic sculptures not only question conventional artistic norms but also delve into the potentialities afforded by emerging technologies. Artists widely acknowledge these sculptures as exemplary instances of invention and inventiveness in the realm of art, allowing them to exhibit their own forms of artistic expression. The introduction of 3D printers in ceramic sculpture production represents a significant milestone in the artistic production process. Ceramic sculptures shaped using this production method can be considered the culmination of technical development in ceramic sculpture throughout history.

Conclusion

The production process of ceramic sculptures has undergone significant evolution and transformation throughout history. From ancient civilizations to the modern era, ceramic sculptures have played a significant role in human life as a form of ceramic expression. As a distinct medium of communication, ceramic sculptures transmit emotions, beliefs, and myths between cultures and provide insights into the sociology of the period in which they were created.

Technological advancements have enabled the use of computer-aided design and modeling in the field of ceramics, allowing for the printing of designed products with 3D printers. These tools have expanded the expressive possibilities of ceramic sculpture, enabling artists to explore broader themes and ideas in their work. Thus, this technological advancement has expanded the expressive possibilities of ceramic sculpture, enabling artists to explore broader themes and ideas in their work.

It is essential to recognize that 3D ceramic sculpture production has several benefits; however, it also presents precision and longer production time challenges. Nevertheless, artists can diversify their means of expression and potentially boost the art form's impact on society and the environment by incorporating technology into ceramic sculpture.

Looking forward, ceramic sculptures will undoubtedly enrich people's emotional and aesthetic experiences, illustrating the potential and latitude of artistic expression, owing to the conveniences provided by 3D ceramic printers and computer-aided modeling tools. This exquisite art form will endure as a considerable aspect of our cultural heritage, advancing and conforming to evolving times. This research seeks to offer a comprehensive overview of the past and future of ceramic sculpture, with the aim of inspiring upcoming artists, students, and enthusiasts. Furthermore, it aims to contribute to the wider conversation on the evolution of art forms in the digital era. Ultimately, ceramic sculpture is a testament to the enduring influence of human creativity and demonstrates the capacity of art to adapt and flourish in a world that is always changing.

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