The Evolution of Craftsmanship from Necessity to Creativity

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This research explores the link between traditional craft and contemporary technology, with an emphasis on the Ancient Greek concepts of Techne and Episteme. Analyzing the historical evolution of craftsmanship and the relationship between theoretical knowledge and practical proficiency, the study shows how technological innovations in tools and processes have continuously revolutionized human creativity. The study also discusses current issues such as how mass production affects craftsmanship and whether robotic production can be integrated with traditional craftsmanship values. This integration addresses issues such as the continued functioning of the craftsman in a rapidly changing technical environment and the preservation of the essence of craftsmanship in the age of automation. In this context, this study highlights the importance of process-oriented and adaptive approaches to production by examining the dynamic interaction between tools, techniques and creative processes. It also explores how robot technology can mimic the flexibility of traditional crafts by introducing elements of improvisation and creativity into the production process. In the field of craft and technology, this method encourages the coexistence of tradition and innovation, providing new paradigms for the production of distinctive, high-quality products.

Keywords: Craftsmanship, Techne, Episteme, Robotic Manufacturing, Technology.

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Zorunluluktan Yaratıcılığa Zanaatkârlığın Evrimi

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Bu araştırma, Antik Yunan'ın Techne ve Episteme kavramlarına vurgu yaparak geleneksel zanaat ile çağdaş teknoloji arasındaki bağlantıyı incelemektedir. Zanaatın tarihsel gelişimini ve teorik bilgi ile pratik yeterlilik arasındaki ilişkiyi analiz eden çalışma, araç ve süreçlerdeki teknolojik yeniliklerin insan yaratıcılığında nasıl sürekli devrim yarattığını göstermektedir. Çalışma aynı zamanda seri üretimin zanaatkârlığı nasıl etkilediği ve robotik üretimin geleneksel zanaatkârlık değerleriyle entegre edilip edilemeyeceği gibi güncel konuları da tartışılmaktadır. Bu entegrasyon, hızla değişen teknik ortamda zanaatkârın işlevini sürdürmesi ve otomasyon çağında zanaatkârlığın özünün korunması gibi konuları ele almaktadır. Bu bağlamda, bu çalışma araçlar, teknikler ve yaratıcı süreçler arasındaki dinamik etkileşimi inceleyerek üretime yönelik süreç odaklı ve uyarlanabilir yaklaşımların önemini vurgulamaktadır. Ayrıca, robot teknolojisinin üretim sürecine doğaçlama ve yaratıcılık unsurlarını katarak geleneksel zanaatların esnekliğini nasıl taklit edebileceğini araştırmaktadır. Zanaat ve teknoloji alanında bu yöntem, gelenek ve yeniliğin bir arada var olmasını teşvik ederek özgün, yüksek kaliteli ürünlerin üretimi için yeni paradigmalar sunmaktadır.

Anahtar Kelimeler: Zanaatkârlık, Techne, Episteme, Robotik Üretim, Teknoloji.

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1. INTRODUCTION

From the dawn of civilization, crafting has been integral to human survival and cultural expression, bridging the gap between necessity and creativity. The ancient Greek concept of *Techne*, often translated as 'craft', embodies the skillful practice of making and doing. Heidegger emphasizes this connection by stating that the essence of *techne* lies not merely in the act of making or manipulating, but an act of revealing and bringing something into being (Heidegger, 1977). Through this act of revelation, *techne* establishes a connection with *episteme* which is translated as 'knowledge', which pre-exists in the activity of making and its application in the act of producing something that responds to an anticipated need. The link between *episteme* (knowledge) and *techne* (craft) is close to the relationship commonly attributed to the concepts of 'theory' and 'practice' today. Such distinctions, again, blur when we view craft, as it is an activity that incorporates these two concepts, where both practical and theoretical knowledge coexist.

As humans developed sophisticated tools, the relationship between practice and theory or episteme and techne became even more evident. The notion that tools are essentially embodiments of technology is fundamental to understanding the evolution of human innovation (de Beaune, 2004). Each technological innovation reflects an advancement in both theoretical understanding and practical application, demonstrating the evolving relationship between tools and techniques required to use them. Craft is the embodiment of this dynamic interaction (Sinclair, 1995). Each new technique offers a fresh perspective on how tools can be used, which encourages further advancements in technique. This cycle is at the center of human creativity, driving progress across all domains of craft and technology. Over time tools have played an important role in shaping the outcomes of craft, and the very nature of what we consider craft itself.

Traditionally, the craft is understood as the creation of functional items made by hand (Risatti, 2007). Over the years, craft objects have evolved, carrying with them techniques honed over centuries to produce the most functional and efficient products. This transformation reflects a shift from merely creating functional items to embodying a culture's accumulated knowledge and skills. The meaning of craft has evolved, especially as new tools have diminished the necessity of human labor in everyday objects. Technological advancements have introduced new tools and methods, enabling faster production while maintaining or enhancing quality items with the same functionality. In this context, the direct relationship between technology and the evolution of craft plays a crucial role in this development. While mass production is based on the manufacture of the final products, the craft can be considered as a process-oriented production where the product emerges from the craftsperson's direct interaction with the material, using hands-on knowledge. This shift represents the transition from hands-on knowledge to the dominant authority of explicit knowledge (Sennett, 2008). The shift from the use of technology as a tool in the production process to employing technological tools that manage the entire process reduces the role of the craftsperson within the process. Machine-made products, which are cheaper, faster to produce, functionally equivalent, and often artistic imitations of handmade items, have gradually replaced the time-consuming, imperfect yet uniquely crafted products of artisans (Risatti, 2007). This change marked a decline in the importance of craft culture in daily life objects as machine-produced items became more prevalent.

Over time, instead of craft as a handmade practice, as a method of producing everyday objects, the use of manufactured products as a result of mechanized processes has become widespread. As a result of this popularization, the handmade craft object has become, so to speak, an object to be looked at. However, in every period, craft has been reintroduced with a different perspective by using contemporary tools. This article aims to trace the development and transformation of craft and craft objects with mechanization. In particular, it questions what qualifies or can qualify as 'craft' in a world where technological developments are increasingly integrated into production processes. It also aims to explore the changing definition of craft in relation to evolving means of production. Through a review of historical perspectives on techne and episteme as well as contemporary debates on craftsmanship, the paper highlights the complex relationship between human creativity, technological tools, and evolving understandings of craft.

2. CRAFTSMANSHIP IN THE MODERN ERA

The meaning and even the use of the word 'craft' has changed considerably over time. Today, the verb 'to craft' describes a production process and skillful participation. This shift introduces a broader understanding of craft as an approach that integrates knowledge, skills, and work (McCullough, 2010). Before delving into deep discussions about what qualifies as craft, we need to understand the different approaches to producing craft objects. We can classify two main production approaches: result-oriented and process-oriented. In result-oriented production, interventions are made to achieve the envisioned final product by applying pressure to the encountered obstacles. By contrast, process-oriented production evaluates these obstacles and allows decisions about whether to intervene, shaping the outcome as the process unfolds. The resistances we impose on ourselves arise from the expectations we set for the desired result. This can exist in both result-oriented and process-oriented approaches, but the frequency and intensity differ depending on the method. For example, how a carpenter intervenes in a grain of wood depends on whether they are working toward a result or adapting step-by-step within the process.

In result-oriented production, uncertainty can become a problem, leading to frustration as the craftsperson struggles to reach the outcome. On the other hand, the process-oriented production method does not require a clear image of the result. Instead, the craftsperson accepts that the resistance encountered during the process will shape the outcome. They manage the process accordingly, improvising during the process. However, this does not imply that the craft is produced entirely within uncertainty; a stone carver may have an image of the final product in mind, but this image takes shape through various decisions made during the process, considering the stone's hardness, grain structure, and even the color.

Ultimately, it is the management of the production process that determines whether something is considered a craft. A rigid structure based on repetitions in the production process can negatively impact the skills of the craftsperson. The active engagement of the mind in the practical process enables the creation and use of knowledge. Sennett (2008) emphasizes that skill is an educated practice that involves knowledge and highlights that modern technology should not deprive the development of skills by turning the process into a rigid and repetitive one. While modern machines can assist in production, the craftsperson's theoretical and practical skills weaken when they dominate the entire process. Craftsmanship requires a balance where machines are used as tools rather than replacing human skill and creativity. When employed appropriately, technology can enhance precision and efficiency while preserving the craftsperson's engagement in the hand-making process.

In the traditional production approach, the maker also takes on the role of the designer and creates a craft with a balance of aesthetics and functionality. Mass production, as a derivative of this culture, is designed to imitate traditional production methods. When handmade objects began to be mass-produced, significant effort was devoted to replacing the unique qualities of handmade items. However, the widening gap in aesthetic concerns between craft products and machine-made products led to the emergence of a new culture of machine production. Discussions about the machine production of craft objects shifted to debates about the methods and processes of machine production. In this new cultural environment, the focus of machine production broadened to include both functional and aesthetic concerns. This triggered new debates on how craft production can exist when machines are used as tools rather than controllers of the production process.

A pivotal moment in this evolution was the founding of the Deutsche Werkbund in 1907, which brought together artists, industrialists, and art enthusiasts. Werkbund sought to reconnect designers with producers and reintegrate art into the industry, recognizing the value of artistic quality in industrial products. These discussions aimed to develop thoughtfully designed products using new technological tools, even if they differed aesthetically from previous craft cultures. This raises the question: Can production using the latest technological tools still be considered craft? This question challenges the criteria we use to define what constitutes a craft today.

3. CRAFTSMANSHIP IN ROBOTIC MANUFACTURING

The fundamental difference between the use of machines in production and the use of tools in craft lies in direct control through the human body. When guided by the sensitivity of the body and the precision of human hands, tools enable a more direct and intimate relationship between the material and the maker. This human touch brings uniqueness to the production process, allowing the craftsperson to make spontaneous, on-the-spot decisions in response to material, function, and design, and becomes a process of production that reflects the craftsperson's knowledge and intuition. In this process, the craftsperson is a producer with full control over both design and implementation. On the other hand, the rise of mechanization fundamentally changed the dynamic between design and production, creating a distinction between the two. As machines have taken over much of the production process, a new practice has emerged that increasingly determines design by the capabilities of the machines. Unlike the human hand, machines follow preset programs, repeating the same task with the same precision over and over again. This static, standardized production form not only reduced the designer's direct involvement in the production process but also led to designs being shaped according to what machines could achieve rather than the creative decisive process of the designer.

The alienation between the designer and production, created by the decline of tool use in favor of machine dependency, has begun to change with the use of machines as tools. In 2006, Gramazio and Kohler pioneered research into the possibility of experimental use of machines in design and fabrication. Utilizing the precision of this advanced tool, they introduced a new form of production and design by laying bricks according to computationally designed patterns (Bonswetch et al., 2006). Initially, the focus was on understanding the potential of robots through an experimental approach. This approach can be interpreted as bridging the gap between craft and mechanization, allowing machines to become tools in the hands of designers. Designers could now engage directly with the material and the fabrication process reminiscent of traditional craftsmanship. The exploration of the potential of machines has created interest within the discipline of design, especially in the context of fabrication and creation. But can we consider production through machines as an act of craftsmanship? In a process where the human hand does not directly manipulate the material, but instead designs how that manipulation will take place and anticipates its outcomes, can robotic production be classified as craft? These questions lead us to reconsider what the act of craft is. Craft is the process of manipulating material through tools with technique (McCullough, 2010; Risatti, 2007). This manipulation emerges through knowledge of the tool, the material, and the technique (the use of the tool) with a skillful application of the knowledge.

For a craft product to be considered “successful”, the craftsperson must have extensive knowledge and expertise in all three key areas: material, tool, and technique. With a deep understanding of these parameters, both individually and together, a master craftsperson can intuitively control the process. This tacit knowledge enables the craftsperson to successfully manipulate the material and the tool through their intuitive actions. When a ceramic artist shapes clay on a wheel, they are aware of how each movement will shape the material. This process is guided by an intuitive "feel" for the act of clay shaping. The artist senses the amount of water in the material and adds water intuitively, or they adjust the pressure applied to the material where they perceive the uneven thickness. Therefore, integrating the principles of craft into robotic manufacturing, several fundamental questions arise: How can a hand’s intuitive knowledge be translated into a robotic process? How can the relationship between material and tool be preserved when the hand is replaced by a robot?

Perhaps it is too early to answer these questions. Considering the evolution of traditional craft production methods over the centuries, the culture created and the knowledge accumulated, a similar culture is certainly possible to build in the field of robotic fabrication, which dates back only 20 years. Research so far has been invaluable for the development of this culture. Early work has focused primarily on understanding the robot's capabilities and exploring what is possible to achieve with it. As researchers became more skillful in using the robot, the goal of understanding the robot shifted to work on outcome-oriented productions. Current research continues to push the boundaries of the robot's capabilities and develop its creative fabrication potential. In all this robotic fabrication research, the three main parameters, material, tool, and movement, which are parallel to the craft, are studied in detail. Many schools and projects have been working for years on studying and improving these parameters. Some of them extend their research by working over the years using the same tools and materials. An important example is the research at ICD/ITKE, University of Stuttgart, which has been developing the production method used in the project they started in 2012 with new trials until 2024. During this time, both the materials used and the tools attached to the robotic arm have evolved and diversified. This research, the ICD/ITKE Research Pavilion, involved the construction of a pavilion using a resin-saturated fiber stretching technique with a robotic arm (Waimer et al., 2013; Knippers et al., 2015). Over the years, knowledge has developed between the tool and the researchers in the same way as in a traditional craft production process, and the technique and skill of using the tool have been mastered (Prado et al., 2014; Schieber et al., 2015; Koslowski et al., 2017; Solly et al., 2018; Rongen & Koslowski, 2019; Gil Pérez et al., 2022; Pérez et al., 2022; Schlopschnat et al., 2023).

Nevertheless, it may be too early to consider these robotic productions as 'craft'. The knowledge generated in these long-term research processes is closer to the outcome-oriented production methodology discussed in Chapter 2. In contrast, traditional craft is typically associated with a process-oriented production methodology where the making process is as important as the final product. The relationship and intuition built on years of practice between hand and material remain difficult to emulate in robotic processes despite advances in robotic skill and precision. However, if robotic manufacturing can evolve to integrate process-oriented values rather than just outcome-oriented ones, a new form of craftsmanship may emerge. By combining human intuition with the precision and flexibility of robotic systems, this "new craft" will open new avenues for creative expression and push the boundaries between humans and machines in the act of making.

4. THE FUTURE OF CRAFT AND ROBOTIC MANUFACTURING

The ability to integrate the precision and efficiency of robotic systems with the flexibility, adaptability, and process-oriented nature of traditional craft is a development that will define the viability of craft in robotic manufacturing. This integration is not just about the application of existing robotic technologies to craft processes but requires that how robots are used within the design and manufacturing continuum is appropriate to the parameters of craft production. Current research over the past few years has demonstrated developments that could go beyond treating robots as basic tools, such as a hammer or a pencil. Instead of being machines that perform defined tasks, robots can become adaptive and dynamic tools that can respond to the ever-changing needs of both design and fabrication. This method allows the designer to perceive, organize, and improve the connection between materials, tools, and techniques in real-time. Therefore, robots become more than just tools, they become collaborators in the creative process. To realize this vision, two human characteristics need to be integrated into the robot: perception and decision-making.

Robots have one-way information transfer due to their design. The code that instructs the movement is programmed and transferred to the robot system and the robot completes the task given to it according to these instructions. During this process, the robot operates 'blindly' by following the given motion coordinates without precepting and receiving any feedback from its environment. While this one-way information transfer can be limiting for production processes that focus on achieving a predefined result, it becomes a highly productive feature in creative processes where the aim is to explore the potential for randomness and emergence. The robot's 'blind' movements, in this case, offer a context for generating the unpredictability and emergent behaviors fundamental to innovative discoveries in design and fabrication. Such studies are frequently found in the literature (Dörfler et al., 2014; Romana et al., 2016; Tokac et al., 2021; Bar-Sinai et al., 2023). However, relying only on one-way information transfer can create limitations as more complex interactions with the robot's environment and material are required. This creates the need for two-way information flow, where the robot not only executes commands but also perceives its environment and relays it to the designer. This need has led to research focusing on enabling robots to sense and interact with their environment in real-time. Researchers have developed ways for robots to receive feedback from their environment by integrating various sensors into robotic systems (Luo et al., 2020; Mitterberger et al., 2020; Burden et al., 2022; Luo, 2023). This has created a two-way flow of information between the robot and the environment in which it operates. This sensory capability gives the robot an awareness of its environment, allowing adjustments to be made according to real-time conditions. For the designer, this creates the possibility of controlled randomness in the creative fabrication process. Instead of simply following predefined movement coordinates, the robot can now detect changes in the properties of the material and adapt its actions accordingly. This dynamic interaction between the robot and its environment introduces an element of instability that can be used creatively, blending the precision of robotic manufacturing with the fluidity and randomness typically associated with craftsmanship.

For decision-making, artificial intelligence (AI) and machine learning are being introduced into the manufacturing process (Brugnaro & Hanna, 2019; Gu & Yuan, 2024). These technologies enabled robotic systems to “learn” from their perceptions of materials and the environment to improve their actions over time (Liu et al., 2022). Such advances allow robots to exhibit a level of intuitive behavior approaching human-like decision-making and responsiveness. For example, a robot equipped with sensors and AI capabilities can detect subtle changes in the texture or resistance of a material and adjust its movements accordingly, much as a skilled craftsman does when shaping clay or carving wood. This ability to react and adapt in real-time is essential for achieving the nuanced results typically associated with handmade objects. Moreover, incorporating controlled randomness and unpredictability into robotic processes can further enhance the uniqueness of each handmade product, creating results that reflect the randomness and variety that are distinctive features of traditional craft.

Is it possible to define the results of fabrication in which a robot's perception and decision-making abilities are developed as “craft”? Can this more autonomous form of production be categorized within the craftsmanship? Answers to these questions depend to an extent on how we approach fabrication and the tools used in the craftsmanship process. Craftsmanship is not just a method of making, but a holistic approach to creation that emerges from the creator's relationship with materials and the environment. Each act of creation becomes an instrument for exploring and refining ideas, adapting them to the needs of the object, the materials at hand, and the context in which it is situated. Craft, then, is defined not only by manual labor or the use of specific tools but by the subjective experience that shapes the process and the product. Applying this understanding of craft to robotic manufacturing, the distinction lies in how the robot is perceived and used. The robot can indeed fit a broader, evolving definition of craft if it is seen as an advanced tool that works, learns, and adapts in a structured yet dynamic creative process that is an extension of the designer's vision. Craft in this case lies in the deliberate design of the production process, where both human creativity and robotic skills work together to achieve a thoughtful and refined outcome.

5. CONCLUSION

Although it may be a bit of a paradox to conduct craft processes using contemporary technologies in the digital age (McCullough, 2010), the desire to rethink the enriching world of craft with current technologies is quite meaningful and valuable. As robots become part of the creative process, not only the role of the craftsperson inevitably transforms, but also the traditional concept of craft is being redefined in the context of robotic fabrication. This redefinition opens up new creative possibilities, allowing designers and makers to explore the full potential of combining technology with the process-oriented nature of traditional craft. In this new paradigm, the craftsperson is not a maker who manipulates materials by hand, but a designer, controller, and executor of robotic fabrication processes. In this context, craftsmanship becomes less about the physical act of making and more about the thoughtful arrangement of materials, processes, and tools, whether human hands or robotic arms. However, does the absence of the hand in the production process imply that the product and the process can no longer be characterized as craft? It is worth remembering that craftsmanship (*techne*) emerges through knowledge (*episteme*). Craftsperson's deep knowledge of the material, combined with the robot's precision and efficiency, can create a class of innovative products that push the boundaries of what is possible with traditional manual methods (Ingold, 2013). Through countless trials and errors, the designer, or in this case craftsperson, masters the skill of controlling the robot. This process of trial and error is a learning space for the designer where knowledge is generated and further refined. Unlike the traditional craftsperson who engages in hands-on learning, the designer's process is much slower and less instantaneous due to the absence of direct haptic feedback. This lack of physical, tactile feedback interrupts the flow of knowledge generation that is typically at the very center of the craft process. As a result, the development of skills in robotic manufacturing has taken place over the years, and knowledge accumulates more slowly compared to the fast, intuitive learning that occurs in hand craftsmanship. The blending of these elements creates a new art form that embraces the precision and capabilities of modern technology while preserving the spirit of traditional craftsmanship.

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Conflict of Interest Statement

The manuscript titled "The Evolution of Craftsmanship from Necessity to Creativity" has not been published, in the press, or submitted simultaneously for publication elsewhere.

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