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The use of modern materials and technologies in the development and production of forged art objects

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Abstract

The article discusses the trends and features of the use of modern materials, as well as technological solutions in the field of the development and production of forged art objects. Indeed, modern raw materials and technologies open up new horizons for artistic forging, turning it into an actual tool for forming an aesthetic environment. At the same time, despite the rapid progress, several contradictions are associated with the choice of materials, optimization of technologies, applied techniques, and methods, as well as preserving the value of products (in an artistic context). The study aims to identify the possibilities of integrating material and technological developments into the process of creating forged art objects, taking into account their functional and aesthetic features. This paper analyzes approaches to the selection of materials, including stainless steel, composites, textured coatings, etc. D., and also studied innovative options, in particular, the tools and potential of 3D printing, and heat treatment. The conclusions formulated in the article emphasize the importance of achieving and maintaining a balance between traditions and the latest production methods. The above will be useful for craftsmen in the field of forging, designers, architects, and researchers who study the nuances of applying breakthrough developments in art

Keywords: Forged art object; Composition; Forging; materials; Metal; Technology; Art products

1. Introduction

Wrought iron products, originally associated with utilitarian purposes, have gained the status of artistic expression in the modern world. Today, these art objects represent a synthesis of traditional craftsmanship and contemporary materials, enabling the creation of unique works of art that combine aesthetics, durability, and functionality. This process requires the application of innovative technologies, which help unlock new dimensions of potential.

When addressing the research problem, it is pertinent to note that traditional forging art, in the context of modern technological advancements, faces the necessity of integrating the latest materials and metalworking techniques to meet contemporary aesthetic and functional demands. However, insufficient exploration of the impact of innovations on the artistic component of these products limits the capabilities of artisans. This underscores the need for a comprehensive study of approaches to the design and production of forged art objects that harmonize traditional craftsmanship with innovation.

2. Material and methods

The preparation of this article involved comparative analysis, systematization, classification, and generalization. The sources on the topic explore numerous facets of the subject. Questions of manufacturing technology and material selection for artistic forging are addressed in the works of A.V. Bogdanov, O.L. Babasheva [1], D.M. Oleinikov, and A.V.

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Shchekin [9]. These studies analyze the sequence of operations with a focus on innovative methods, revealing opportunities for creating complex art objects. They also provide insights into the nuances of using stainless steel as a durable and aesthetically appealing material that extends the lifespan of products and reduces maintenance needs.

The aesthetic and compositional aspects of forging are discussed in the works of N.V. Domovtseva [3] and E.A. Il [4]. These authors describe the fundamental principles of compositional design, emphasizing harmony with the architectural environment. Attention is paid to the specifics of decorative stylization, highlighting the importance of uniqueness in designing art objects for urban settings.

The historical and cultural perspective of forging and its potential in educational contexts are explored by Yu.S. Kalganova [5]. The author argues that analyzing samples from past eras contributes to the development of students' cultural competencies and enhances their artistic taste.

The challenges of integration into architectural and urban environments are the focus of publications by V.A. Kotova, R.M. Mukhametov [6], and I.G. Mukhnurova, A.I. Vagina [7]. These studies examine the role of forged art objects in creating a harmonious appearance for a location, taking into account the interests of residents. They also characterize the impact of modern techniques on the visual identity of buildings and the improvement of their architectural perception.

Technical aspects of material selection for artistic forging are presented in the work of S.I. Popova and colleagues [10], as well as in an online review [8]. These sources emphasize the importance of material identification and restoration, contributing to the preservation of cultural heritage.

Economic and resource-related aspects are discussed by K.N. Gaivoronskaya [2]. This article addresses the issue of the high cost of forging processes and proposes solutions for cost optimization without compromising product quality.

Thus, the literature review demonstrates that researchers pay close attention to the technological, material, organizational, and aesthetic aspects of forging and its integration into architectural environments. However, contradictions are observed in approaches to material selection, such as balancing the cost and durability of stainless steel versus traditional metals, which remain insufficiently explored. Additionally, the problem of automating the forging process, particularly with the use of additive technologies, has received limited attention, restricting the prospects for modernizing the industry.

3. Results and discussion

Historically, forging has relied on the use of iron and steel, whose mechanical properties enabled the creation of complex shapes at high temperatures. However, in recent decades, new alloys, including aluminum and titanium compositions, have become available, offering several advantages:

- Lightweight properties;
- Corrosion resistance;
- High plasticity when heated.

The use of composite solutions, such as carbon fiber with metal inserts, represents a significant step in expanding artistic possibilities. These materials allow the creation of lightweight structures with unusual textures, which is particularly valuable for art objects integrated into interiors or open spaces.

It is important to emphasize that modern materials used in forging differ from traditional iron and steel not only in mechanical properties but also in aesthetic parameters, providing artisans with greater opportunities for artistic expression.

Thus, following a brief overview of this evolution, the following classification of metal groups used in forging is presented (Fig. 1).

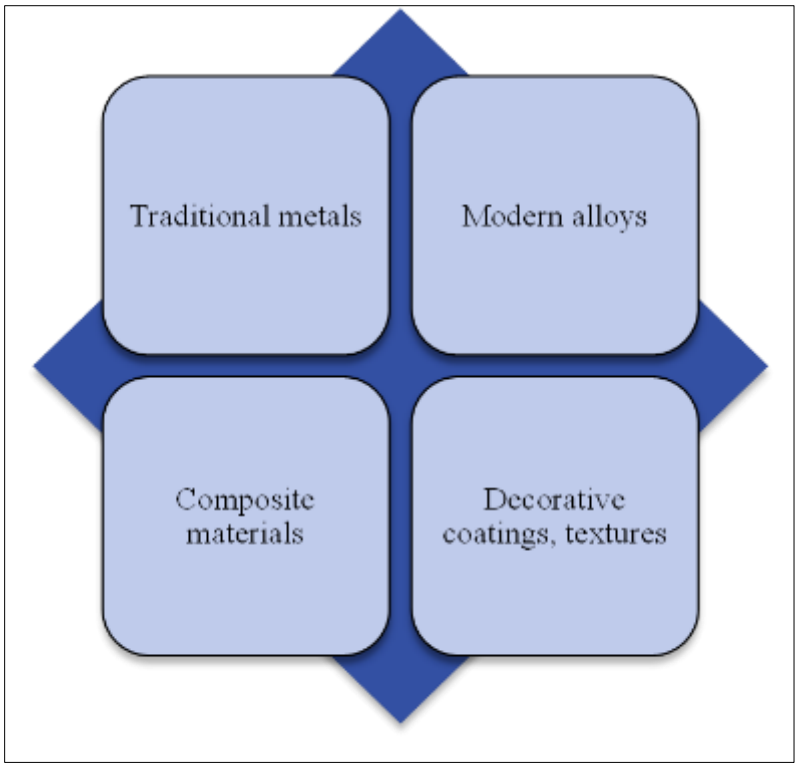

Figure 1 Systematization of groups of materials [2, 5, 8, 10]

Among traditional materials, iron and steel remain primary due to their strength and plasticity. Different grades of steel allow for the adjustment of product characteristics: high-carbon steel is used for creating particularly strong elements, while low-carbon steel is suitable for detailed work. Cast iron is employed for massive decorative structures, such as lanterns and fences, with its textured surface adding visual depth to the creations.

Modern solutions include aluminum alloys. Their lightweight and corrosion resistance make aluminum an ideal material for outdoor installations. Its lightness enables the creation of large forms while minimizing structural loads.

Titanium alloys also warrant mention. Their high resistance to aggressive environments, combined with a unique color spectrum achieved through thermal treatment, makes titanium highly sought after for creating art objects intended for marine or industrial settings.

As for stainless steel, its glossy surface and corrosion resistance make this material ideal for modern minimalist designs and work involving mirror effects [9].

The use of composite solutions is gradually expanding. For example, metal-ceramics combine the strength of metal with the heat resistance of ceramics, enabling the creation of complex textured forms. Similarly, carbon fiber with inserts offers a unique combination of lightness and strength, imparting high decorative value and resistance to loads.

Another significant category to consider is decorative solutions. Modern technologies allow the creation of coatings with high wear resistance and intricate color transitions. Heat-resistant lacquers are used to protect products from external influences. Methods such as oxidation and anodizing are employed to give surfaces unique colors, ranging from deep black to iridescent hues. Powder coatings provide smooth, durable finishes in a wide palette, including textured options that mimic wood, granite, or patinated metal [4].

Modern production in this field is no longer limited to manual labor. Increasingly popular methods include laser cutting, which ensures precision in preparing blanks and allows for the addition of intricate decorative elements; plasma forging, which facilitates work with metals requiring elevated processing temperatures; and 3D printing with metal powders, which offers prospects for creating prototypes and small components with minimal waste.

The integration of machine vision technologies and process automation enables artisans to monitor product quality at every stage, which is particularly crucial for large-scale projects.

Thus, progress in metallurgy and material processing has provided numerous innovative tools, significantly broadening the scope of artistic forging (Fig. 2).

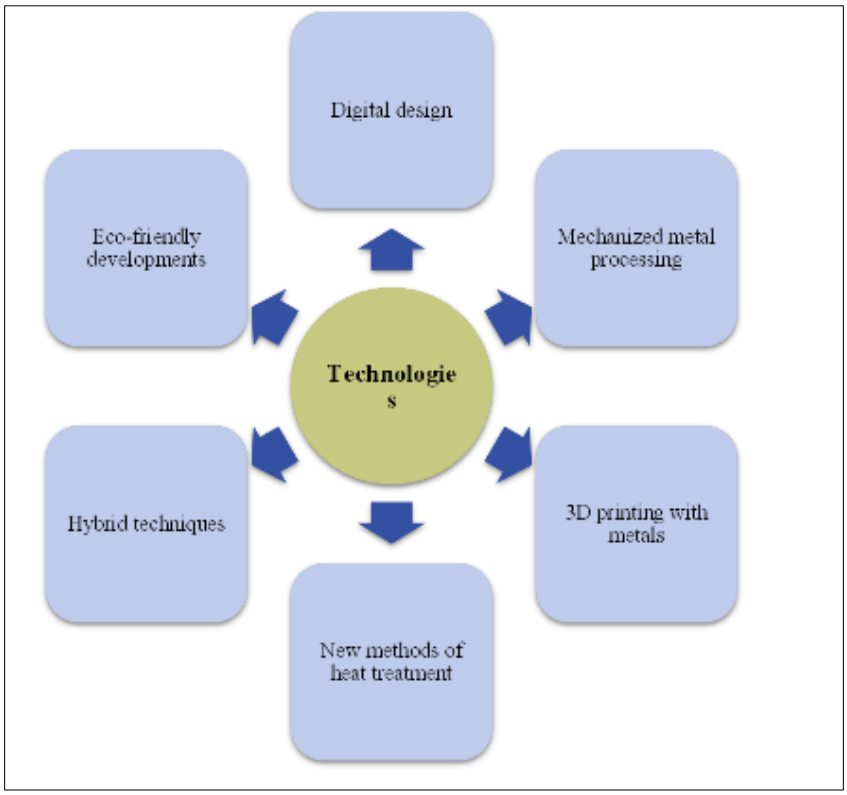

Figure 2 Modern technological aspects of the development and production of forged art objects [1, 6, 7]

Digital solutions in design provide high-precision execution. CAD systems (AutoCAD, Rhino, SolidWorks) are used in creating digital models of art objects, enabling detailed planning of form, texture, and the interaction of various materials. Programs for 3D visualization, in turn, allow clients and artists to evaluate the future object at an actual scale and within a given environment.

Regarding mechanized metal processing, attention should be given to laser cutting, which enables the creation of intricate patterns and highly precise elements. This technology is suitable for preparing complex-shaped blanks. Plasma cutting and forging are used for thick metal sheets and components, ensuring smooth, durable edges. Manual and automated grinding techniques help achieve various levels of smoothness, ranging from mirror-like polish to rough textures that highlight the artist's intent.

3D metal printing is developing at a rapid pace. Technologies such as SLM (Selective Laser Melting) are used to create components from powdered materials. This approach allows experimentation with forms that are impossible to achieve using traditional forging methods. Significant attention is given to the detailing of small elements: intricate ornaments and components are produced with 3D printers and integrated into larger objects.

In terms of thermal processing options, quenching and tempering are particularly notable for regulating the strength and plasticity of the material. Hardened components exhibit increased wear resistance, which is essential for functional art objects. Additionally, thermal coloring enables the creation of unique color effects, such as blue, purple, and gold hues on steel or titanium.

Hybrid methods include techniques like welding combined with forging. This integration allows the creation of large-scale objects while preserving the aesthetics of traditional craftsmanship. The inclusion of other materials—such as glass, wood, and polymers—within metal structures further expands opportunities for artistic expression.

Finally, the field of eco-friendly technologies holds considerable importance. In this context, the use of recycled metal takes precedence. Recycling old items reduces material costs and minimizes waste. Furthermore, energy-efficient furnaces deserve mention. Modern induction and gas furnaces provide even heating with reduced energy consumption.

Another important area of research focuses on aesthetic aspects (Fig. 3) and functional adaptation.

Modern forged art objects represent not only decorative elements but also functional structures such as railings, gates, and furniture. From an aesthetic perspective, the value of such items lies in the harmony of form and material. For instance, combining metal with wood, glass, or polymer variations creates unique visual effects. A prime example is art objects crafted using the technique of "organic forging," where lines mimic natural forms such as vines, waves, or tree trunks. Achieving such results is impossible without employing contemporary modeling methods, such as three-dimensional design software.

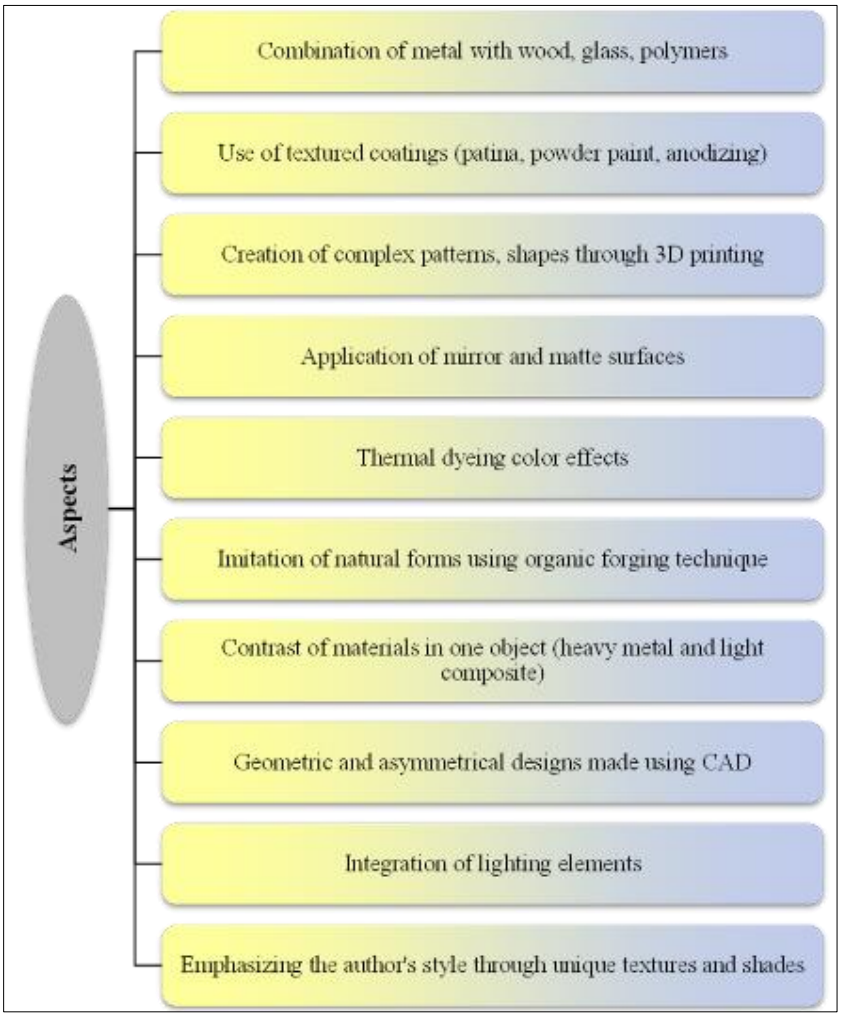

Figure 3 Aesthetic aspects of the use of modern materials and technologies in the development and production of forged art objects [3, 4]

In the era of sustainable development, environmental considerations have gained paramount importance. Metal scrap and forging waste are often recycled for reuse, reducing environmental impact. The use of modern technologies, such as laser cutting that minimizes leftover material, also positively contributes to waste reduction.

Additionally, the custom creation of forged art objects reduces overproduction, aligning the industry with the concept of personalized design. Using energy-efficient furnaces to heat metal further decreases the carbon footprint

4. Conclusion

The use of modern materials and technological advancements has fundamentally transformed the approach to creating forged art objects, enabling the integration of artistic craftsmanship with innovation. The application of new alloys, processing techniques, and digital design opens additional opportunities to realize ambitious ideas while enhancing the ecological efficiency of production.

The implementation of innovative solutions in artistic forging not only improves the quality of products but also facilitates the creation of objects with unique characteristics. The future of this industry lies in the synergy between traditional craftsmanship and digital technologies, where creations result not only from physical labor but also from intellectual creativity. Technological progress is likely to continue inspiring artisans to explore new forms, textures, and materials, unlocking possibilities for ideas that were previously deemed unattainable.

Thus, modern forged art embodies both the preservation of traditions and a field for experimentation, where progressive ideas and creative spirit merge into a unified whole, inspiring artisans and captivating audiences.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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