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From Spark to Sculpture: A Practice-Based Exploration of Betta Fish Form Using Stainless Steel Rods

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Abstract

The development of three-dimensional creation techniques using metal materials, particularly stainless steel, provides opportunities for artists and designers to explore unique and aesthetically valuable organic curves, especially in functional objects such as furniture, interior accessories, public sculptures, and metal crafts. These biomorphic forms are chosen because they differ from common geometric shapes and can create visual appeal. This research aims to explore the application of the SMAW welding technique on stainless steel rods to create three-dimensional artworks with organically inspired forms. The study employs a practice-based research method, combining direct practice with result analysis to generate new knowledge. The technique used is Shielded Metal Arc Welding (SMAW), which utilizes heat from an electric arc between a shielded electrode and the base metal to melt and fuse the materials into a solid alloy. In this research, 4 mm diameter stainless steel rods were used as the primary material, and the process included preparation, welding execution, grinding, polishing, documentation, and practice-based analysis. The findings demonstrate the successful application of the SMAW technique in forming betta fish fins with organic curve characteristics. This work proves that practice-based research is an effective approach for generating artistic and design innovations through material and technique exploration. This research contributes to the development of experimental material-based metal crafts and enriches contemporary art discourse by creating original works through the innovative application of the SMAW welding technique to stainless steel rods in producing complex three-dimensional organic forms, such as betta fish fins, which have rarely been explored in previous studies.

1. INTRODUCTION

The development of techniques for creating three-dimensional artworks using metal materials has had a significant impact on the world of fine arts and design. One of the metal materials that is increasingly being used is stainless steel, which offers advantages in strength, corrosion resistance, and its ability to be shaped into various aesthetic forms, with the final result capable of being polished to a shiny finish [1]. In the development of three-

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dimensional artworks, organic curved forms have gained increasing attention among artists and designers, as they are associated with visual fluidity, emotional resonance, and natural harmony that differ from rigid geometric shapes [2], [3], [4].Some famous artworks made of stainless steel include sculptures by artists such as Jeff Koons and Anish Kapoor, who use this material to create monumental installations. Works like Koons' Balloon Dog or Kapoor's Cloud Gate (commonly known as "The Bean") demonstrate the potential of stainless steel for producing smooth, organic curved surfaces [5]. Although those large-scale works typically employ stainless steel plates combined through advanced welding techniques such as TIG or MIG, the technical challenge of shaping and joining the material to achieve seamless organic forms remains comparable. In contrast, this study explores similar aesthetic and material principles by applying the SMAW welding technique to stainless steel rods (4 mm in diameter) within a smaller-scale, practice-based contextThese organic curved shapes arhighly suitable for application in functional objects such as structural elements, building facades, modern architectural decoration, furniture, accessories, interior decorative elements, modern sculptures, monumental art installations, and metal crafts, as they not only provide technical benefits and corrosion resistance but also offer unique aesthetic value that distinguishes them from other materials [6].

Previous literature reviews indicate that arc welding techniques, specifically Shielded Metal Arc Welding (SMAW), have been widely used in the metal welding industry, including for creating art pieces [7], [8]. However, most previous studies have focused on geometric or structural forms, rather than exploring the potential of stainless steel for complex organic or biomorphic shapes. Research combining SMAW welding on stainless steel rods to create fluid, organic forms—such as betta fish fins—remains scarce and under-explored. Therefore, this study addresses this gap by applying SMAW to 4 mm stainless steel rods to investigate the possibilities of forming expressive, three-dimensional biomorphic shapes through a practice-based approach.

A literature review with the research article titled "*Las Busur untuk Penciptaan Karya 3 Dimensi Permukaan Lengkung Bahan As Stainless Steel Bentuk Oval*" discusses the use of the electric arc welding technique (SMAW) in creating three-dimensional artworks with curved surfaces using oval-formed stainless steel rods [9]. This research successfully demonstrated that SMAW welding can be applied in the creation of three-dimensional organic curved artworks from stainless steel rods, allowing artists to create complex and aesthetically pleasing forms with adequate structural strength. Building upon this foundation, the present study aims to address the lack of investigation into how SMAW welding parameters can be utilized to model complex, flowing organic structures inspired by betta fish fins. Specifically, this research explores the potential of stainless steel rods as a medium for generating biomorphic forms through a practice-based approach, contributing new insights into material experimentation within contemporary metal art.

Figure 1. The Result of Welding Stainless Steel Rods into Organic Oval-Formed Curves. [Source: [9]]

The research article titled "*Riset Praktik Eksperimental Las Busur Dengan Material As Stainless Steel untuk Penciptaan Bentuk Katak Pohon*" discusses the creative process of making three-dimensional tree frog sculptures using Shielded Metal Arc Welding (SMAW) technique with stainless steel rods [10]. This study successfully demonstrated that the arc welding technique can be applied to create three-dimensional sculptures with organic curved forms, integrating industrial welding methods into fine art practices. However, the study does not provide a detailed discussion of welding flow control, surface finishing, or the precision needed to achieve highly detailed, glossy organic surfaces — aspects that are crucial in representing delicate structures such as betta fish fins. Therefore, the present research focuses on these less explored aspects by investigating how SMAW welding parameters and surface finishing techniques can be optimized to produce fine, biomorphic stainless-steel forms with smooth organic curvature.

Figure 2. The Results of Welding the Stainless Steel Rod into a Tree Frog Form and (on the Right) the Proportional Comparison of the Tree Frog Sculpture with the Artist.
[Source: [9]]

The theoretical framework of this study focuses on the theory of electric arc welding (SMAW), which explains how an electric arc is used to melt and fuse the base metal and the electrode. Comprehensive explanations of the use of electric arcs in the welding process, particularly in the SMAW (Shielded Metal Arc Welding) technique, are provided in the textbooks *Buku Ajar Teknologi Pengelasan* [11] and *Dasar-Dasar Pengelasan* [12]. This process involves the formation of an electric arc that occurs between the electrode and the base metal. It is also explained that the electric arc functions as an intense heat source, capable of melting both the tip of the electrode and the surrounding surface area of the base metal. This heating process is crucial as it allows both the electrode and the base metal to melt and fuse together, forming a solid joint once cooled and solidified [13]. The heat energy generated by the electric arc is sufficient to liquefy the welding materials, enabling a

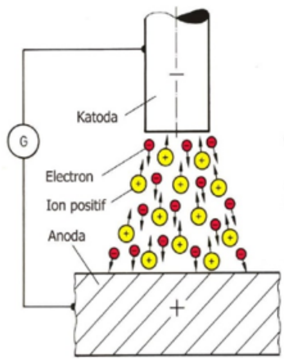


Figure 3. The Diagram of Electric Arc Ignition Shows That the Wire/Electrode Functions as the Cathode (Negative Pole), While the Surface of the Workpiece or Base Metal Serves as the Anode (Positive Pole).
[Source: [12]]

precise metal fusion process with long-term durability and quality.

A clear understanding of arc distance control between the electrode and the base metal is crucial to ensuring that the welding results meet the desired standards. Maintaining a consistent distance allows for optimal heating and prevents defects in the welded joint. The use of flux in electrodes is also elaborated in detail in several references [11], [14]. Flux serves to protect the weld area from oxidation and atmospheric contamination during the welding process, while also providing alloying elements that aid in the unification of metals. Thus, a deep comprehension of the electric arc mechanism is essential in ensuring high-quality welding, as thoroughly explained in the available reference books.

Three-dimensional artworks with organic curved forms possess a high and unique aesthetic value. This concept is exemplified in Hara's exploration of design philosophy and the significance of organic forms in creating works that are not only functional but also aesthetically pleasing. Hara, a renowned Japanese designer, emphasizes the importance of simplicity and beauty in design, often drawing inspiration from natural and organic shapes. He delves into how soft curves and asymmetrical forms provide profound aesthetic value to various product and furniture designs. Hara highlights that such flowing designs are more than mere forms; they manifest a deep philosophy of balance between humanity, culture, and nature [2].

Lawson explains that organic curved forms in furniture imbue a sense of vitality and dynamism, liberating designs from the rigidity and monotony often associated with more conventional geometric shapes. These curves not only enhance visual appeal but also create a sense of flow and flexibility that harmonizes with the surrounding space. By integrating organic curves, furniture transcends its role as a functional object and becomes an element that enriches the aesthetic experience of its occupants, fostering a deeper connection between the object and its environment [3].

Orr elaborates that organic curved forms found in nature offer an indescribable aesthetic value, exuding natural elegance and fluidity. In design, such curves often establish a harmonious balance between structure and function, moving away from rigid geometric shapes in favor of more natural flows. These forms enhance both the visual and emotional experiences of observers, as they remind us of the boundless beauty and complexity of nature while fostering a sense of connection to the larger natural world [15].

Similarly, Hosey emphasizes that designs incorporating organic curved forms not only possess strong visual appeal but also reflect harmony between humans and nature. These curves are often inspired by natural patterns found in flora and fauna, and their application in three-dimensional design creates objects or buildings that feel more vibrant and organic. By employing curves, designs can avoid rigid and mechanical impressions, instead offering a natural ambiance that fosters an emotional bond between viewers and their surroundings. According to Hosey, this approach can enhance aesthetic experiences while also promoting environmental sustainability [4].

Collectively, the perspectives of Hara, Lawson, Orr, and Hosey emphasize the profound aesthetic and philosophical significance of organic curved forms. Although expressed in different contexts—ranging from product design to architecture and environmental aesthetics—their ideas converge on the notion that fluidity, asymmetry, and natural curvature evoke harmony, vitality, and emotional connection between human, object, and environment. This synthesis highlights that organic form is not merely an aesthetic choice but a conceptual framework that requires technical precision to manifest in physical material.

In the context of this study, the aesthetic principles articulated by Hara and the dynamic flow emphasized by Lawson necessitate a welding and finishing process capable of translating these visual and philosophical ideals into tangible form. Accordingly, SMAW was selected for its versatility and accessibility in manipulating stainless steel rods, allowing for controlled, expressive shaping of complex biomorphic structures. The subsequent finishing stages aim to achieve smooth, reflective surfaces that embody the natural elegance and visual fluidity discussed by Orr and Hosey. This theoretical and technical alignment underscores the integration of aesthetic philosophy with material experimentation, forming the foundation of this practice-based exploration.

2. METHODS

The research methodology employed in this study is practice-based research. According to Silvia Gherardi in her book *How to Conduct a Practice-Based Study: Problems and Methods* (2019), this creative-based approach is an approach that integrates direct practice with theoretical analysis to generate new knowledge. In this methodology, researchers do not solely rely on theoretical analysis but also engage in firsthand experiences during the creation or practice process. This approach involves systematic observation, reflection, and documentation throughout the process of creating artworks, designs, or other practical skills. One distinctive feature of this methodological framework is that its outcomes often take the form of tangible products or artworks, which serve as evidence of the knowledge produced, rather than solely academic reports or writings. This method is particularly valuable in the fields of art and design, where experimentation and creative processes are central to research [16]. In line with this epistemological stance, Tower [17] reinterprets Hans-Jörg Rheinberger's notion of experimentalism, describing art practice as a "future-generating machine." Through what Rheinberger calls "repetition with difference," artistic experimentation becomes a site where new knowledge emerges from material engagement, reflection, and the productive role of surprise. This view underscores the generative and exploratory nature of practice-based methodologies, positioning artistic action as an epistemic process in itself. This epistemological orientation also resonates with the educational philosophy of the Bauhaus, which Johnson and Oates [18] reinterpret through the framework of powerful knowledge. Their analysis reveals how the Bauhaus learning model integrated craft-based practice with generalisable conceptual understanding, enabling students to translate abstract design principles into practical creative actions. In a similar vein, practice-based research bridges experiential knowledge and theoretical reflection, producing transferable insights through material experimentation and reflective making.

A similar perspective is offered in *Designing and Conducting Practice-Based Research Projects: A Practical Guide for Arts Student Researchers* by Lyle Skains [19]. Skains provides a step-by-step guide for understanding and applying this creative-based approach . This approach highlights the importance of practice as an integral component of the research process, where new knowledge emerges through direct engagement in creative practices, such as art, design, or other creative disciplines. Skains emphasizes that this reflective artistic inquiry differs from traditional approaches by focusing not only on the final outcomes but also on the creative process itself as a source of data and reflection. Through detailed examples and practical strategies, this book aids researchers in designing relevant and meaningful research projects while providing a robust theoretical foundation to support the validity of this methodological framework. In a similar philosophical vein, Matthews [20] introduces the idea of art practice as "the daily extraordinary," describing creative making as a continuous process of discovery within ordinary experiences. Her philosophy of inclusivity situates artistic practice as both accessible and transformative—where reflection, experimentation, and embodied engagement reveal meaning in the everyday. This notion reinforces the methodological stance of practice-based research, which values iterative creation and reflective awareness as generative sources of artistic and educational knowledge.

Another important reference is *The Routledge International Handbook of Practice-Based Research*, edited by Vear (2024). This comprehensive guide explores various ways in which creative practices, such as art, design, and performance, can be used as primary methods for generating new knowledge. Featuring diverse perspectives from international experts, the book discusses how creative practices can be integrated into academic frameworks to produce innovative and relevant research outcomes. It also addresses the theoretical and methodological challenges frequently encountered by practice-based researchers and offers strategies to overcome these challenges, such as emphasizing critical reflection, systematic documentation, and connections to existing literature [21].

As Linda Candy states in her paper *Reflective Practice Variants and the Creative Practitioner*, she argues that critical reflection and variations in reflective practice are essential for creative practitioners to develop new knowledge through this reflective artistic approach . Critical reflection is a key element in practice-based research because it allows practitioner-researchers to connect their experiences with relevant theories, refine their approaches, and make significant contributions to their fields. Critical reflection involves an analytical process in which a practitioner or researcher observes their experiences, actions, or decisions; evaluates the outcomes objectively and subjectively; relates them to existing theories, contexts, or literature; identifies what worked, what did not, and why; and makes changes or adjustments based on the insights gained [22], [23].

Reflection in the context of practice-based research, as discussed in *The Reflective Practice Guide* by Barbara Bassot, refers to the critical thinking process carried out by practitioners regarding actions or experiences they have undertaken. It is a way of continuously and personally reflecting on and evaluating practice or process. The goal is to improve the quality and self-understanding on an ongoing basis. Reflection is more introspective and personal, aiming to enhance self-awareness and continuous development. It is a part of practice-based research that allows practitioners to critique and develop their practices [24].

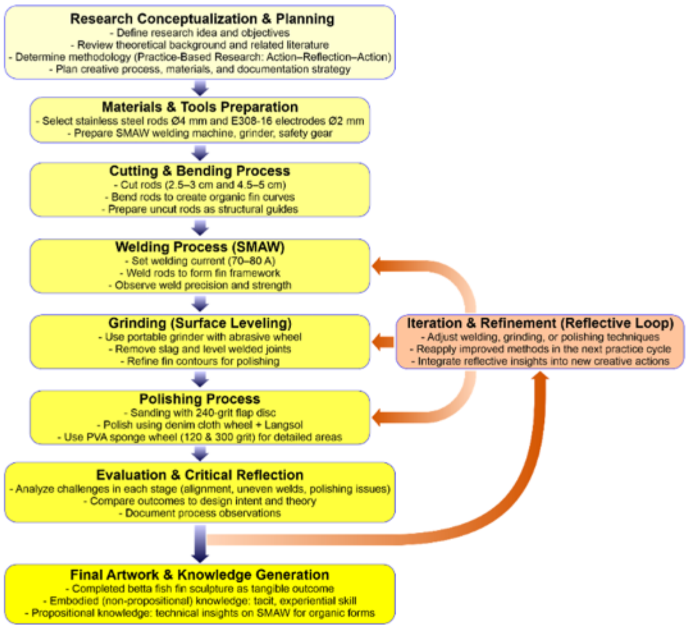
Brigid Mary Costello connects the concept of rhythm with the process of creating art in the context of practice-based research (PBR). Rhythm, in this sense, is not just about tempo or speed but refers to the patterns and dynamics that emerge at each stage of the art-making process. The creation of art never happens in a linear or orderly fashion. In practice-based art creation, reflection and evaluation of the work in progress play a crucial role in its development. This rhythm is an essential part of creation, where artists feel their "groove" or creative flow, enabling them to adapt and move forward despite facing obstacles. In other words, art creation within this iterative reflective process involves a dynamic and often irregular process, closely tied to reflection, iteration (a process of repeating with improvements aimed at achieving better results over time), experimentation, and social interaction [25].

This study employs a practice-based research method to explore the SMAW welding technique on stainless steel rods in the creation of betta fish-inspired artworks. This approach enables the researcher, who is also an artist, to integrate theory with direct practice. The process of creating three-dimensional artworks from metal materials like stainless steel rods requires iterative experimentation and technical adaptation, including testing how electric arcs melt and fuse the material to form organic curves resembling fish fins. Through hands-on practice, the researcher not only gains technical insights but also identifies challenges and adjustments needed to achieve optimal results. Moreover, critical reflection plays a crucial role in connecting practical experiences with relevant theories, refining creative approaches, and generating new knowledge. Systematic documentation of each stage of the process—from welding and grinding to polishing—provides deep empirical data and enriches understanding of how this technique can be applied to produce original artworks. This approach not only results in innovative creations but also contributes to the development of techniques and creative practices that benefit other artists and designers.

The objective of this study is to explore the application of SMAW techniques on stainless steel rods in creating three-dimensional artworks with organic curves, focusing on the design of betta fish fins as an example. This research aims to provide new contributions to the fields of three-dimensional art, metalcraft, and design, while enriching contemporary art discourse by advancing more innovative artistic forms. The scientific novelty of this study lies in the application of SMAW techniques to stainless steel rods for producing three-dimensional artworks with organic curves, a method that has not been widely explored in previous research.

In this study, the creative process follows the Action–Reflection–Action model of practice-based research, emphasizing iteration and critical reflection as integral components of knowledge generation. Each stage of welding, grinding, and polishing was followed by reflective evaluation and re-adjustment, allowing technical experimentation to evolve into creative insight. This approach is consistent with the findings of Puppe, Jossberger, and Gruber [26], who empirically demonstrated how expert and novice sculptors differ in their perception, reflection, and creation processes—showing that reflection-in-action serves as a key mechanism for adaptive artistic learning. Through this cyclical process, new understandings emerged—both non-propositional knowledge (knowledge through practice, embodied in the betta fish sculpture itself) and propositional knowledge (knowledge about applying SMAW welding parameters to form organic, biomorphic shapes).

The reflective and iterative rhythm of the process not only enhanced the quality of the final artwork but also demonstrated how technical mastery and artistic intuition can intersect in contemporary metal art creation. A schematic flowchart illustrating the stages of this practice-based process—from conceptualization to reflection—is presented to clarify the methodological structure and flow of this study.



Flowchart 1. Schematic Flowchart of the Practice-Based Research Process in the Creation of Betta Fish Fin Artworks Using SMAW Technique. [Source: Author's Analysis, 2025]

In this study, the creative process follows the Action–Reflection–Action model of practice-based research, emphasizing iteration and critical reflection as integral components of knowledge generation. Each stage of welding, grinding, and polishing was followed by reflective evaluation and re-adjustment, allowing technical experimentation to evolve into creative insight. Through this cyclical process, new understandings emerged—both non-propositional knowledge (knowledge through practice, embodied in the *Betta fish* sculpture itself) and propositional knowledge (knowledge about applying SMAW welding parameters to form organic, biomorphic shapes). The reflective and iterative rhythm of the process not only enhanced the quality of the final artwork but also demonstrated how technical mastery and artistic intuition intersect in contemporary metal art creation. The following schematic flowchart illustrates the stages of this practice-based process—from conceptualization to reflection—clarifying the methodological structure and iterative rhythm of the study.

The flowchart visualizes the methodological structure of the study, following the *Action-Reflection-Action* model. It depicts the iterative process from conceptual planning, material preparation, welding, grinding (surface leveling), and polishing, to critical reflection and knowledge generation, emphasizing reflective feedback loops that foster continuous refinement in practice.

3. RESULTS AND DISCUSSION

In this study, the SMAW (Shielded Metal Arc Welding) technique was employed to create betta fish fins using stainless steel rods with a diameter of 4 mm. The primary objective of the research was to explore the capability of SMAW in producing organic curved forms with high aesthetic value, applicable to three-dimensional art made from stainless steel rods. The research process began with the preparation of materials and tools, followed by welding, grinding, polishing, and practice-based documentation and analysis.

3.1. Materials and Tools Preparation

The first stage of this study involved the preparation of materials and tools. The primary material used was a 4 mm diameter stainless steel rod, selected for its durability and resistance to corrosion. Additionally, this material is relatively easy to work with using the SMAW technique, allowing for the creation of more complex shapes. The E308-16 electrode was employed in this study, as this type of electrode is suitable for welding 304 stainless steel, providing high-quality joints that are clean, aesthetically pleasing, and highly resistant to corrosion [27]. Along with the materials, the equipment used included an SMAW welding machine and protective gear to ensure safety during the welding process.

Table 1. Table of Materials Used in SMAW Welding Technique for Stainless Steel Rod in the Creation of Betta Fish Artwork.
[Source: Author's Analysis, 2025]

No.	Material Description	Welding	Grinding	Polishing
1	Stainless steel rods Ø4mm	■		
2	E308-16 stainless electrode Ø2mm	■		
3	T41 WA60 SBF cutting grinding wheel	■		
4	A24S BF grinding wheel		■	
5	60 grit flap sanding disc		■	
6	240 grit flap sanding disc			■
7	120 grit PVA sponge wheel		■	
8	300 grit PVA sponge wheel			■
9	Denim fabric polishing wheel			■
10	Langsol			■

Table 2. Table of Equipment Used in the SMAW Welding Technique for Stainless Steel Rod in the Creation of Betta Fish Artwork.
[Source: Author's Analysis, 2025]

No.	Equipment Name	Welding	Grinding	Polishing
1	Angle grinder	■	■	■
2	Inverter welding machine	■		
3	Hand rebar bender	■		
4	Chipping hammer	■		
5	Long nose pliers	■		
6	Locking pliers	■		
7	Bench vice	■		
8	Face shield welding	■		
9	Leather welding gloves	■	■	■
10	Dust mask		■	■
11	Safety glasses		■	■
12	Ear plug		■	■

Before the welding process, stainless steel rods with a diameter of 4 mm were cut into lengths of approximately 2.5–3 cm and 4.5–5 cm. The purpose of this cutting was to facilitate the formation of the desired organic forms during the welding process. Some rods were left uncut to assist in creating curved forms while also serving as a general guide for achieving the overall organic form design.

Figure 4. The Process of Bending Stainless Steel Rods Using a Vise (Left). The Process of Bending Stainless Steel Rods Using a Metal Bending Tool (Center). The Process of Cutting Stainless Steel Rods Using Locking Pliers and an Angle Grinder (Right).
[Source: Research Team, 2025]

Figure 5. Stainless Steel Rod Segments With a Length of Approximately 2.5–3 cm (Left). Stainless Steel Rod Segments With a Length of Approximately 4.5–5 cm (Right).
[Source: Research Team, 2025]

3.2. Welding Process

The welding process begins with setting the electrical current according to recommended welding parameters. For using E308-16 Ø 2 mm electrodes with stainless steel rods Ø 4 mm, the current is set at approximately 60–70 amperes for slower welding speeds or welding on thin materials. In contrast, a higher current of about 70–80 amperes is used for welding that requires deeper penetration or faster welding speeds. In this study, a current of 70–80 amperes was employed to ensure optimal welding without excessively melting the material or creating weak joints.

The SMAW welding technique utilizes an electric arc between the electrode and the base metal to melt the metal and fuse it into a cohesive structure. During the welding process, the researcher monitored the precision of the welds and ensured that the process produced strong joints and surfaces smooth enough to proceed to the grinding stage.

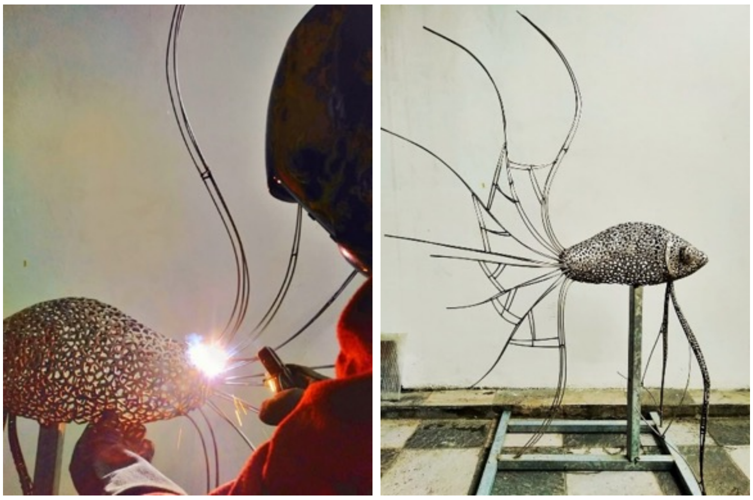


Figure 6. Stainless Steel Rod Segments With a Length of Approximately 2.5–3 cm (Left). Stainless Steel Rod Segments With a Length of Approximately 4.5–5 cm (Right).
[Source: Research Team, 2025]

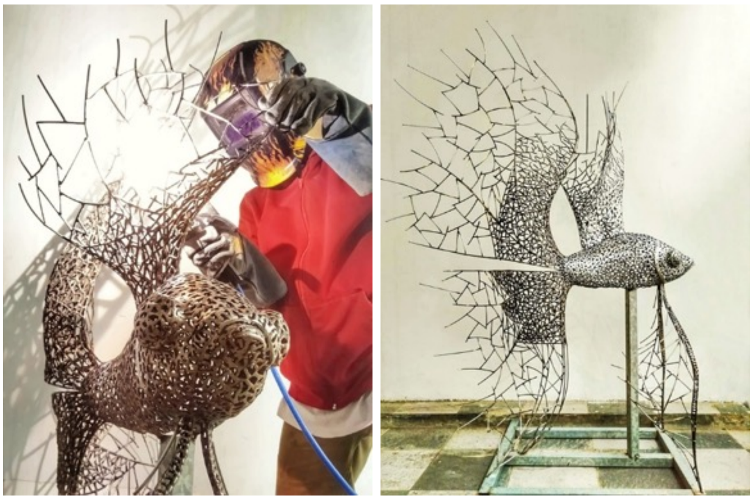


Figure 7. Continued Welding Process of the Fish Tail Fin Form (Left). The Welded Betta Fish Tail Fin Shape Nearing Completion (Right).
[Source: Research Team, 2025]

Figure 8. Perpendicular Welding Position to The Welding Object (Left). Angled Welding Position Leaning to The Right of The Welding Object (Right).
[Source: Research Team, 2025]

3.3. Grinding Process

After the welding process, the next stage is grinding, which aims to even out the welded surface and remove any residual slag adhering to the metal [28]. Grinding is performed using a handheld angle grinder combined with various grinding discs that function as surface smoothers [29]. The goal is to ensure that the joints created through SMAW welding appear smooth and neat. This process is crucial because a smooth surface enhances the aesthetic value of the artwork and facilitates the polishing stage. Additionally, grinding helps correct minor errors that may occur during welding, such as uneven welds or forms that do not align with the design, and assists in shaping or leveling the stainless steel surface [30].

Figure 9. Grinding The Dorsal Fin of The Fish (Left). Grinding The Pectoral Fins of The Fish (Right).
[Source: Research Team, 2025]

3.4. Polishing

The next process is polishing, which provides a smoother and more lustrous finish to the artwork [31]. Prior to polishing, a sanding stage is conducted using a stacked abrasive flap disc with 240 grit. Polishing is performed with a handheld angle grinder, combined with a specialized polishing disc for stainless steel that smooths the metal surface and achieves the desired shine. The polishing disc is fitted with a denim cloth wheel and paired with polishing compound (*Langsol*) to expedite the shining process. Polishing also aims to eliminate scratches or minor imperfections that may have occurred during the grinding stage. After polishing, the betta fish fins made from stainless steel rods exhibit a sleek and glossy finish, aligning with the desired aesthetic design criteria.

Figure 10. Sanding Using a Stacked Abrasive Flap Disc With 240 Grit (Left). Followed by Polishing Using a Denim Cloth Polishing Wheel, Applied With Polishing Compound (Langsol) and Rubbed Onto the Sanded Stainless Steel Surface (Right).
[Source: Research Team, 2025]

Figure 11. The Polished Surface of the Fish's Left Pectoral Fin and Head (Left). The Polished Surface of The Left Side of The Tail Fin (Center). The Polished Surface of The Right Side of The Tail Fin (Right).
[Source: Research Team, 2025]

Critical Reflection on Welding Stainless Steel Rods for Betta Fish Fin Creation: Challenges and Solutions

Creating betta fish fins from stainless steel rods is a process that demands precision, skill, and patience. As an artist engaged in the creation of this metal-based artwork, the author encountered various technical challenges that needed to be addressed to achieve the desired forms and final results. This reflective process aligns with Linda Candy's [32] notion of critical reflection, in which practitioners systematically observe, evaluate, and refine their creative actions to generate new knowledge through making. Similarly, Barbara Bassot [24] emphasizes reflection as an ongoing, cyclical process that enhances self-understanding and the quality of practice. In cognitive terms, this process can also be interpreted through Kenett's [33] concept of creative knowledge networks, where reflection operates as a dynamic restructuring of associative memory—enabling practitioners to connect distant concepts and experiences into novel aesthetic insights. This reflective awareness, as also demonstrated by Puppe, Jossberger, and Gruber [26], distinguishes expert sculptors from novices by allowing adaptive problem-solving and deeper understanding during the act of creation.

Welding: Aligning Shapes and Maintaining Surface Consistency

One of the primary challenges during the welding stage was ensuring the accurate alignment of bent stainless steel rods to achieve the desired curvature of the betta fish fins. The bending process required meticulous attention, as each piece needed to fit seamlessly into the overall curved structure. Initially, difficulties arose when the bent rods were hard to join perfectly, resulting in uneven weld surfaces. To address this issue, I utilized a hand rebar bender, which proved effective in achieving smoother surfaces for welding.

Another challenge involved joining the rods with uniform surface heights. Often, the welds would result in uneven heights, with certain areas protruding more than others. This issue posed additional challenges during the grinding stage, as extra care and effort were required to level the surfaces. Ensuring consistent surface heights at each joint was critical to maintaining the smooth and flowing curves of the fins.

This stage exemplified Candy's [32] concept of *critical reflection-in-action*, as real-time evaluation during welding guided immediate adjustments. Each correction not only improved the structure but also deepened the researcher's understanding of material behavior and technical limits.

Grinding: Precision in Sequence and Tool Selection

Following welding, grinding became an essential step to level and clean the curved surfaces of the betta fish fins. The primary challenge here was selecting the correct sequence of grinding tools. Using grinding discs that were too coarse or too fine could compromise the grinding results and risk damaging the stainless steel surface.

As an initial step, I used a coarse grinding disc to remove excess material from the welds. This was followed by a medium grinding disc to further smooth the surface, and finally, a fine grinding disc for precise finishing. This process required careful attention to the sequence and pressure applied to ensure a smooth and consistent finish. Additionally, special attention was needed for angular joint sections of the fins, as improper grinding in these areas could result in uneven surfaces.

Through reflective evaluation [24], the choice of tool and grinding sequence evolved as part of an iterative learning process. Each misalignment or surface flaw became data for analysis, guiding subsequent refinement.

Polishing: Perfecting the Surface with Care

After grinding, the polishing stage added the final touch to the artwork. However, polishing came with its own set of challenges. One significant issue was the frequent snagging of the denim cloth polishing wheel on uneven stainless steel surfaces. Due to the uneven planes formed by the welded rods, the polishing wheel struggled to reach all areas smoothly.

To address this, I carefully adjusted the angle and positioning of the polishing wheel to navigate the gaps between the rods and the polishing surface effectively. Special attention was given to the fin tips, where the arrangement of rods was less dense. For these sections, the denim cloth polishing wheel proved ineffective, and I switched to a PVA sponge wheel with 120 grit, which was better suited for smoothing rougher surfaces. This was followed by a PVA sponge wheel with 300 grit to achieve a finer and glossier finish.

This problem-solving stage reflects Costello's [25] notion of "rhythmic adaptation" within practice-based research, where the artist responds to the dynamic rhythm of material resistance, forming a dialogue between action, reflection, and material behavior.

Evaluation and Critical Reflection: Refining the Process

This entire process provided invaluable insights. Critical reflection on each stage offered a deeper understanding of the importance of precision and accuracy in every step. The challenges faced—whether during welding, grinding, or polishing—presented opportunities to evaluate and refine techniques while discovering more effective solutions.

The final outcome, a set of betta fish fins crafted from stainless steel rods, demonstrated how patience and attention to detail in welding and polishing could result in a smooth, glossy, and aesthetically pleasing finish that aligns with the intended design. Despite the technical challenges, these critical reflections enabled me to continually grow in the art of metal welding, particularly SMAW techniques, and to appreciate the importance of iteration and experimentation in practice-based art creation. These reflections not only improved the technical execution but also informed a deeper aesthetic awareness, which will be further discussed in the following section on Aesthetic Evaluation and Theoretical Reflection.

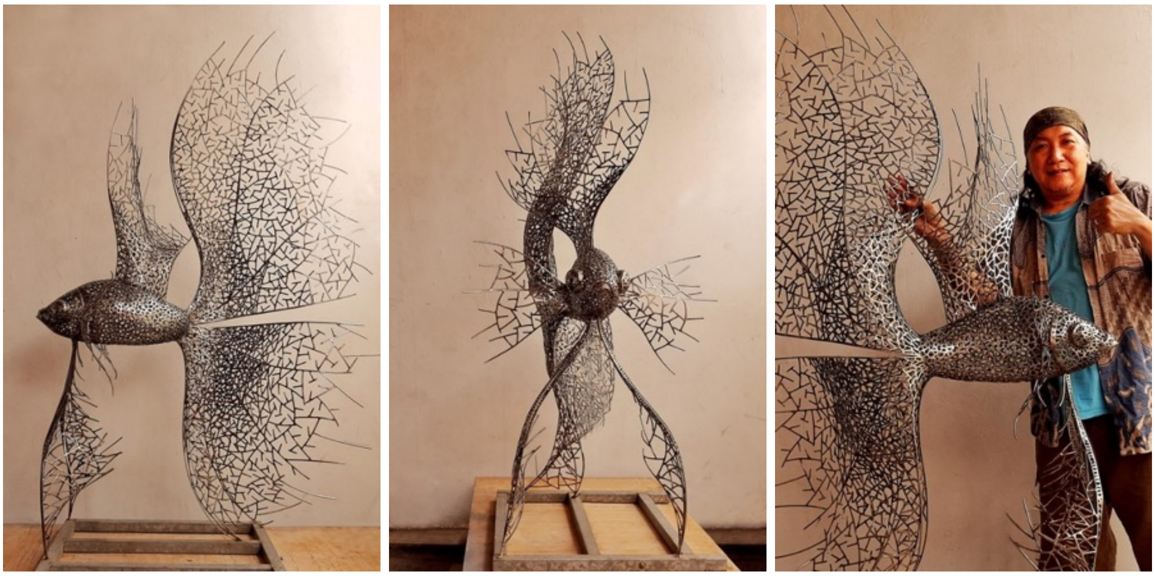


Figure 12. The Betta Fish Artwork Made From Stainless Steel Rods Viewed From the Right Side (Left). The Artwork Viewed From the Front (Center). A Comparison of the Artwork With Human Proportions/The Author (Right).
[Source: Research Team, 2025]

Aesthetic Evaluation and Theoretical Reflection

The final form of the betta fish fins embodies the organic design aesthetics discussed by Hara [2], Lawson [3], and Hosey [4], which emphasize curvature, rhythm, and visual lightness as markers of natural form. The welded stainless rods, arranged in an open mesh-like pattern, evoke a sense of fluidity and transparency reminiscent of the natural motion of fish fins underwater. This pattern not only enhances the visual dynamism but also conveys a symbolic lightness, aligning with Orr's [15] concept of visual fluidity in organic design. Moreover, this process of shaping and refining stainless-steel rods through direct physical engagement reflects what Wagemann and Starosky [34] describe as *aesthetic production*—a dynamic intertwining of mental intention and material interaction in which action and perception mutually shape artistic meaning. Their perspective on embodied and enactive aesthetics reinforces the notion that creative insight emerges not only from conceptual planning but from the bodily negotiation with material resistance during making. Furthermore, this dynamic material expression resonates with Ströbele's [35] notion of elasticity in twentieth-century sculpture, where the interplay between material rigidity and visual flexibility becomes an aesthetic metaphor for movement and vitality. In this context, the stainless-steel rods, though structurally rigid, are perceived as fluid and living, reflecting the sensuous and rhythmic qualities central to organic form. This reflective metallic surface also engages the viewer's perceptual and physiological responses. As demonstrated by Tröndle and Tschacher [36] in their *eMotion—Mapping Museum Experience* project, aesthetic encounters with artworks can elicit measurable bodily reactions and spatial behaviors, showing that perception of form and material is deeply intertwined with embodied experience. In addition to these embodied and physiological dimensions, cognitive framing also plays a significant role in shaping aesthetic judgment. As Bordens [37] explains, contextual information about artistic style can modify appreciation and evaluative responses, influencing how viewers internally define what constitutes art. Thus, the perception of the stainless-steel *betta fish* sculpture extends beyond visual observation—it emerges through the integration of embodied sensation, reflective cognition, and contextual awareness, illustrating the holistic nature of aesthetic experience in contemporary metal art.

Comparative Analysis with Previous Studies

In comparison with previous studies on metal-based sculpture, such as Costin et al. [38], who emphasized technical precision and the integration of engineering in sculptural practice, and Kanwal [39], who explored decorative surface treatments through innovative patina recipes, this study advances the discourse by integrating critical reflection theory within a practice-based framework. While prior works focused mainly on fabrication efficiency or aesthetic finish, this research foregrounds the reflective and iterative process as the core mechanism for generating artistic and technical knowledge. This perspective resonates with Altinoba's [40] examination of Harriet Hosmer's engagement with mechanical invention, which highlights how technological processes can embody creative authorship rather than mere mechanical repetition. Similarly, the use of SMAW welding in this study demonstrates how a mechanical technique can serve as a medium of reflective innovation, transforming technical experimentation into aesthetic expression. Thus, it contributes a complementary perspective that bridges craftsmanship, reflection, and aesthetic innovation in contemporary metal art practice.

Potential Applications and Broader Impact

Beyond the studio context, the welding and shaping techniques developed in this study offer potential applications in public art, interior environments, and art education. In public art, the open, organic stainless structures can be adapted as site-specific installations or sculptural landmarks that evoke movement and lightness, contributing to human-centered and culturally reflective urban spaces [41]. Within interior design, these techniques can inspire sculptural partitions, lighting fixtures, or wall reliefs that integrate aesthetic expression with spatial function, leveraging contemporary material manipulation and fabrication methods that enable innovative forms and textures [42]. In the context of art education, this project exemplifies a reflective pedagogical model in which critical reflection and material experimentation are combined to foster deeper engagement with process-based creativity and material intelligence; applying reflective practice frameworks supports students in critically evaluating their creative decisions while exploring socially and culturally responsive approaches to form and material [43]. By integrating technical skill development with reflective inquiry, the approach enhances artistic proficiency and cultivates adaptive, conceptually informed practitioners capable of bridging aesthetic, functional, and societal considerations in contemporary art and design.

4. CONCLUSION

Based on the results of this study, it can be concluded that the SMAW (Shielded Metal Arc Welding) technique is effective in forming organic betta fish fin structures using stainless steel rods. This practice-based research successfully integrates theoretical understanding with direct creative practice through iterative experimentation and reflection. The process of welding, grinding, and polishing resulted in a dynamic, strong, and visually refined sculptural work that fulfills the intended aesthetic criteria.

From an artistic perspective, this study contributes to the field of fine arts by producing an innovative stainless-steel sculpture that expands the discourse of contemporary metalcraft art. Through reflective experimentation, the work explores biomorphic forms and the expressive potential of welded structures to represent organic movement. The resulting sculpture demonstrates how rhythm, curvature, and transparency—derived from the arrangement of stainless steel rods—can embody the visual lightness and fluidity associated with natural forms such as fish fins.

From a technical and methodological standpoint, this research verifies that the SMAW welding technique can be adapted to produce complex organic curves on stainless steel rods while maintaining structural strength and surface precision. The structured application of critical reflection, as proposed by Candy (2006) and Bassot (2023), was essential in optimizing each stage of the creative process. Reflection-in-action not only improved the technical execution but also enhanced the researcher's aesthetic sensitivity and material awareness, forming a replicable framework for other artist-researchers exploring metal-based sculpture.

Future studies may further investigate the application of alternative welding techniques such as TIG (Tungsten Inert Gas) or MIG (Metal Inert Gas) welding to compare welding precision, thermal control, and overall efficiency in forming complex organic curves on stainless steel rods. Building on these technical explorations, subsequent creative research could focus on developing suspended stainless-steel sculptures that explore the interaction of form, light, and gravity, as well as integrating stainless steel with andesite stone to examine the aesthetic and structural dialogue between industrial and geological materials. The contrast between reflective, lightweight metal and dense volcanic stone offers rich symbolic and material possibilities, representing a harmony between human-made and natural elements. Such practice-based investigations would not only advance technical understanding of joining dissimilar materials but also expand innovation in contemporary metal art, public installations, interior design, and art education.

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REFERENCES

[1] B. Mullen, "Art on stainless steel," in *Stainless Steel for Architectural Use*, C. A-10, Ed., Pennsylvania: ASTM International, 1969, p. 6. doi: https://doi.org/10.1520/STP45897S.

[2] K. Hara, *Designing design*. Zurich: Lars Müller Publishers, 2014.

[3] S. Lawson, *Furniture design: An introduction to development, materials and manufacturing*. London: Laurence King Publishing, 2013.

[4] L. Hosey, *The shape of green: Aesthetics, ecology, and design*, 2nd ed. Washington,

DC: Island Press, 2012.

[5] Q. Zhang and S. Y. Wang, “The influence and application of stainless steel to modern sculpture,” *Appl. Mech. Mater.*, vol. 620, pp. 417–420, 2014.

[6] L. W. Zahner, *Stainless steel surfaces: A guide to alloys, finishes, fabrication and maintenance in architecture and art*. New Jersey: John Wiley & Sons, Inc., 2019.

[7] J. W. Mills, *The technique of sculpture*. New York: Watson-Guptill Publications, 1976.

[8] L. Slobodkin, *Sculpture: Principles and practice*. New York: Dover Publications, Inc., 1949.

[9] M. E. Santoso and E. Djakaria, “Las busur untuk penciptaan karya 3 dimensi permukaan lengkung bahan as stainless steel bentuk oval,” *Corak J. Seni Kriya*, vol. 9, no. 2, pp. 151–168, 2020, doi: https://doi.org/https://doi.org/10.24821/corak.v9i2.4076.

[10] M. E. Santoso, “Riset praktik eksperimental las busur dengan material as stainless steel untuk penciptaan bentuk katak pohon,” *Brikolase J. Kaji. Teor. Prakt. dan Wacana Seni Budaya Rupa*, vol. Vol 13, no. No 1, pp. 1–21, 2021, doi: https://doi.org/10.33153/brikolase.v13i1.3644.

[11] Mulyadi and Iswanto, *Buku ajar teknologi pengelasan*. Universitas Muhammadiyah Sidoarjo: UMSIDA Press, 2020. [Online]. Available: https://eprints.umsida.ac.id/8386/1/Buku Ajar_Iswanto.pdf

[12] A. L. Razik, S. Subagyo, M. Alkibzi, Hernita, D. R. Trilaksono, and L. Listriana, *Modul pembelajaran center of excellence welding di SMK dasar-dasar pengelasan*. Jakarta: Direktorat Pembinaan Sekolah Menengah Kejuruan Direktorat Jenderal Pendidikan Dasar dan Menengah Kementerian Pendidikan dan Kebudayaan, 2018. [Online]. Available: https://repositori.kemdikbud.go.id/10819/1/Modul Pembelajaran Center of Exellence Dasar-Dasar Pengelasan.pdf

[13] R. Finch, *Welder’s Handbook: A Complete Guide to MIG, TIG, Arc & Oxyacetylene Welding*, 2nd ed. Tucson: HPBooks, 1997.

[14] F. J. Tulung, *Buku Ajar Praktek Las Listrik*. Tasikmalaya: Perkumpulan Rumah Cemerlang Indonesia, 2022. [Online]. Available: https://www.rcipress.rcipublisher.org/index.php/rcipress/catalog/download/347/525/1365-1?inline=1

[15] D. W. Orr, *The nature of design: Ecology, culture, and human intention*. London: Oxford University Press, 2004.

[16] S. Gherardi, *How to conduct a practice-based study, problems and methods*, 2nd ed. Cheltenham: Edward Elgar Publishing, 2019.

[17] A. Tower, “Art as a Future-Generating Machine: Rheinberger’s Experimentalism in Practice-Based Arts Methodologies,” *Leonardo*, vol. 55, no. 2, pp. 145–148, 2022, doi: https://doi.org/10.1162/leon_a_02103.

[18] M. Johnson and T. Oates, “The Bauhaus as Education Model: Enduring Design and Powerful Knowledge,” *Int. J. Art Des. Educ.*, 2025, doi: https://doi.org/10.1111/jade.12598.

[19] L. Skains, *Designing and conducting practice-based research projects: A practical guide for arts student researchers*. Bristol: Intellect Ltd, 2024.

[20] M. Matthews, “Arts Practice as the Daily Extraordinary: A Philosophy of Inclusivity,” *Int. J. Art Des. Educ.*, vol. 43, no. 3, pp. 448–465, 2024, doi: https://doi.org/10.1111/jade.12520.

[21] C. Vear, Ed., *The routledge international handbook of practice-based research*, 1st ed. London: Routledge, 2024.

[22] L. Candy and E. Edmonds, “Practice-based research in the creative arts: Foundations and futures from the front line,” *Leonardo*, vol. 51, no. 1, pp. 63–69, 2018, doi: https://doi.org/10.1162/LEON_a_01471.

[23] L. Candy, “Reflective practice variants and the creative practitioner,” in *The Routledge International Handbook of Practice-Based Research*, C. Vear, Ed., London: Routledge, 2024, ch. Section 3.

[24] B. Bassot, *The reflective practice guide: An interdisciplinary approach to critical reflection*, 2nd ed. London: Routledge, 2023.

[25] B. M. Costello, “Finding the groove: The rhythms of practice-based research,” in *The Routledge International Handbook of Practice-Based Research*, 1st ed., C. Vear, Ed., London: Routledge, 2024, ch. Section 3.

[26] L. Puppe, H. Jossberger, and H. Gruber, “Creation Processes of Professional Artists and Art Students in Sculpting,” *Empir. Stud. Arts*, vol. 39, no. 2, pp. 171–193, 2021, doi: https://doi.org/10.1177/0276237420942716.

[27] I. Kakkar, A. Pandey, M. Gupta, H. Jaiswal, and • N. Kishore, “ANSI/AWS E308-16 Rutile Electrode : The Effect of Endothermic Materials on Undercut Defect on Low Carbon Stainless Steel,” *J. Inst. Eng. Ser. C*, vol. 94, no. 4, pp. 293–297, 2013, doi: 10.1007/s40032-013-0092-y.

[28] M. N. Ilman and Sehono, *Ilmu dan teknologi pengelasan*. Yogyakarta: Gadjah Mada University Press, 2024.

[29] K. Susanta and K. Syauqi, *Dasar-dasar teknik pengelasan dan fabrikasi logam*. Jakarta: Kementerian Pendidikan, Kebudayaan, Riset, dan Teknologi, 2023.

[30] Buehler, “Grinding and polishing guide,” Buehler.com. Accessed: Jan. 19, 2025. [Online]. Available: https://www.buehler.com/blog/grinding-and-polishing-guide/

[31] K. R. McCoy, *The art of sculpture welding: From concept to creation*. South Norwalk: Industrial Press, Inc., 2015.

[32] L. Candy, “Practice Based Research: A Guide,” Sydney, 2006. [Online]. Available: https://www.researchgate.net/publication/257944497_Practice_Based_Research_A_Guide

[33] Y. N. Kenett, “The Role of Knowledge in Creative Thinking,” *Creat. Res. J.*, vol. 37, no. 2, pp. 242–249, 2025, doi: https://doi.org/10.1080/10400419.2024.2322858.

[34] J. Wagemann and S. Starosky, “Aesthetic Production in Clay Molding: Mental and Dynamically Embodied Action Mediate Between Formal and Material Aspects of Experience,” *Empir. Stud. Arts*, vol. 43, no. 1, pp. 153–187, 2025, doi: https://doi.org/10.1177/02762374241255875.

[35] U. Ströbele, “Elasticity in twentieth-century sculpture,” *Sculpt. J.*, vol. 33, no. 1, pp. 71–92, 2024, doi: https://doi.org/10.3828/sj.2024.33.1.05.

[36] M. Tröndle and W. Tschacher, “The Physiology of Phenomenology: The Effects of Artworks,” *Empir. Stud. Arts*, vol. 30, no. 1, pp. 75–113, 2012, doi: https://doi.org/10.2190/EM.30.1.g.

[37] K. S. Bordens, “Contextual Information, Artistic Style and the Perception of Art,” *Empir. Stud. Arts*, vol. 28, no. 1, pp. 111–130, 2010, doi: https://doi.org/10.2190/EM.28.1.g.

[38] G.-A. Costin, G.-V. Troncuta, A.-C. Lese, and N. Baroiu, “Art and engineering in metal

sculptures," *J. Ind. Des. Eng. Graph.*, vol. 11, no. 1, pp. 23–28, 2016.

[39] A. K. Kanwal, "An Analytical Study of Patina Recipes with Reference to Brass Metal Sculptures," *ShodhKosh J. Vis. Perform. Arts*, vol. 5, no. 1, 2024, doi: https://doi.org/10.29121/shodhkosh.v5.i1.2024.874.

[40] B. Altinoba, "'Anybody can do sculpture, it is purely mechanical': Harriet G. Hosmer and the relation between sculpture, reproduction and machine invention," *Sculpt. J.*, vol. 33, no. 1, pp. 29–46, 2024, doi: https://doi.org/10.3828/sj.2024.33.1.03.

[41] F. Duque, "Public art and the making of urban space," *City, Territ. Archit.*, vol. 1, no. 1, 2014, doi: https://doi.org/10.1186/2195-2701-1-4.

[42] C. Gao, F. Wang, X. Hu, and M. Zhang, "Research on the Analysis and Application of Polymer Materials in Contemporary Sculpture Art Creation," *Polymers (Basel).*, vol. 15, no. 12, 2023, doi: https://doi.org/10.3390/polym15122727.

[43] E. J. Hood and S. Travis, "Critical Reflective Practice for Art Educators," *Art Educ.*, vol. 76, no. 1, pp. 28–31, 2023, doi: https://doi.org/10.1080/00043125.2022.2131201.