Formal Transformation and Conceptual Expression of Firing Traces in Modern Ceramic Art

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Abstract: *In modern ceramic art, firing traces have long been regarded as firing defects, yet they possess the potential to be transformed into an independent formal language and a vehicle for conceptual expression. This paper proceeds from three dimensions: material basis, formal reconstruction, and conceptual projection. It analyzes the generative logic of thermodynamic imprints, natural textures, and shrinkage cracks; explores the abstract extraction of traces, temporal superimposition, and the dialectical relationship between uncontrolled traces and order; and further elucidates traces as evidence of process, the aesthetics of imperfection as a carrier of contingency, and the translation of symbolization and individual memory. The research shows that the formal transformation of firing traces is established on a hierarchical mechanism from materiality to grammar and then to metaphor, providing ceramic art with a surface language system distinct from glaze painting and sculpture.*

Keywords: *modern ceramic art, firing traces, formal transformation, visual grammar, conceptual expression*

Introduction

Firing traces refer to a type of physical imprint that naturally forms on the surface of clay bodies after they undergo temperature, atmosphere, and cooling processes in the kiln, including fire marks, ash-glaze deposits, cracks, melt holes, and smoke stains. Traditional ceramic craftsmanship tends to eliminate or conceal these traces in pursuit of surface uniformity and completeness. However, the development of modern ceramic art has gradually transformed such traces from "defects" into exploitable formal resources. The necessity of this transformation lies in the fact that firing traces directly record the interactive process between fire and clay, possessing a sense of material authenticity that any artificial depiction cannot replace. If directly preserved without transformation, they remain in a state of contingency; if completely eliminated, the unique process language specific to the ceramic medium would be lost. Therefore, a systematic methodology is needed to discuss how firing traces move from natural phenomena to formal organization and then become vehicles of conceptual expression. This paper focuses on the core issue of formal transformation and conceptual expression, and elaborates from three dimensions: material basis, visual grammar transformation, and metaphorical projection, aiming to establish a complete logical chain from generation to signification for firing traces.

1. Material Basis and Formal Generation of Firing Traces

1.1 Thermodynamic Imprint Characteristics on the Clay Body Surface

1.1.1 Surface Deformation Records during the Dehydration and Sintering Stages

During the initial heating stage, the absorbed water and crystal water within the clay body are successively expelled, causing particle rearrangement and the closure or opening of microcracks, and leaving shallow linear or reticular surface lines. When the temperature reaches the sintering range, the low-melting-point components begin to melt, and the liquid phase migrates toward the surface under capillary action, forming glassy patches or localized reflective areas after cooling. The thermal action at this stage pushes the clay from a loose state toward densification and retains undulations and color differences in the transitional state on the surface[1].

1.1.2 Bubble Bursting and Melt-Hole Structures Caused by Local Overheating

Temperature spikes often occur near the kiln wall or the stoking port, causing the viscosity of the liquid phase in the surface layer of the clay body to decrease. The internal gases then expand and break through the surface, forming open pores or melt holes. The diameter, depth, and rim morphology of these melt holes depend on the degree of superheating and the surface tension of the liquid phase. Some melt holes are partially filled by subsequently flowing melts, producing concentric solidification ripples. Such structures are not externally added pits but natural residues after thermal forces exceed the material's tolerance threshold.

1.1.3 Differential Thermal Responses of Different Clay Mineral Components

Variations in the proportions of quartz, feldspar, and kaolinite in clay alter the specific appearance of thermal imprints. High-quartz formulations tend to produce fine crackle patterns upon rapid cooling, whereas high-feldspar formulations tend to form extensive molten spreading. Bodies with higher iron-titanium oxide content generate dark brown to black scorch spots under oxidizing atmospheres, while they exhibit grayish-blue tones under reducing atmospheres. This compositional dependence indicates that thermodynamic imprints are not accidental blemishes but rather a thermal history manual written by the material itself.

1.2 Natural Texture Forms of Fire Marks and Ash Deposits

1.2.1 Linear and Banded Accumulation Patterns Controlled by Flame Flow Direction

When the flame adheres to the surface of the clay body, it drags the melt and ash along the airflow direction, leaving elongated linear or banded traces. The flame-facing side accumulates thickly with a strong sense of flow, while the side away from the flame is relatively clean or has only scattered dot-like attachments. This directionality endows fire marks with a pointing function similar to brushstrokes, capable of implying the movement path of hot air within the kiln. On different orientations of the same object, the density and direction of fire marks vary significantly, forming a non-artificial surface rhythm in the sense of fluid mechanics[2].

1.2.2 Color Layer Differences and Halo Effects under Reducing and Oxidizing Atmospheres

In a reducing atmosphere, carbon monoxide reacts with the iron elements on the surface layer of the clay body, generating halo-like color bands in grayish-blue, bluish-brown, or purplish-gray tones. In an oxidizing atmosphere, it predominantly presents dot-like and strip-like accumulations in warm yellow, ochre red, or orange hues. The alternating changes of atmospheres produce overlapping color layer boundaries on the same surface, with blurred edges of the halo effects and natural transitions. Such color layers are not flat pigment applications, but traces left by the atmosphere, acting as an invisible brush, repeatedly wiping between the glaze and the clay body.

1.2.3 Textural Gradation from Coarse to Fine Based on Ash Particle Size and Viscosity

The particle size of ash deposits ranges from submicron soot to millimeter-scale coarse grains, and the viscosity is influenced by the melting temperature. Fine ash tends to form a smooth thin layer with a silky luster, while coarse grains accumulate into granular or nodular glaze deposits with rough surfaces and diffuse light reflection. Ash particles of different sizes also adhere in layers, with the fine layer at the bottom and the coarse layer on top, producing a textured profile resembling sedimentary rock. This gradational structure makes the object's surface appear as if it has been successively abraded by sands of varying coarseness, yet without any sense of regularity characteristic of artificial polishing.

1.3 Shrinkage Cracking as a Structural Formal Element

1.3.1 Reticular and Radial Fine Cracks Induced by Imbalance of Internal Stress

When the clay body has uneven thickness or when local shrinkage is obstructed, the internal tensile stress induces dense reticular cracks or crack lines radiating outward from stress concentration points. The reticular cracks resemble the mud cracks of a dried riverbed, with fine lines that are interconnected throughout. The radial cracks scatter outward from a central point, with the spacing gradually increasing as they extend. Such cracks do not penetrate the entire body but remain only on the surface layer, producing a visual effect similar to broken glass that has not yet fallen off. Their distribution density is proportional to the stress gradient: the greater the stress, the denser the cracks[3].

1.3.2 Through-Going Wide Cracks Caused by Rapid Cooling and Their Boundary Morphology

When the cooling rate exceeds the thermal shock tolerance limit of the clay body, cracks initiate from edges, holes, or transitional zones between thick and thin sections, producing wide through-going cracks. Such cracks often penetrate the entire wall thickness, with sharp boundaries and few branches. During the later stage of cooling, the two walls of the crack may undergo slight dislocation, forming a stepped cross-sectional profile. This type of wide crack disrupts the complete continuity of the object's surface, yet provides a powerful linear segmentation effect, abruptly cutting the originally smooth curved surface with a deep groove.

1.3.3 Formal Tension between Controllable Pre-Damage and Uncontrollable Propagation

By adjusting the grog content in the clay formulation, altering the wall thickness distribution of the formed body, or locally grooving the surface, one can preselect the general range and direction of cracks to a certain extent. However, the exact location, length, and branching points of each final crack remain the autonomous choice of thermal stress. This coexistence of predetermination and randomness endows cracking with both design intention and the vividness of contingency. The tips of cracks often terminate in hair-like ends, and their spreading tendency is difficult to predict completely, thereby preserving the material's own voice within a rational framework.

2. Formal Reconstruction of Trace Morphology and Visual Grammar Transformation

2.1 Methods of Abstracting Firing Traces

2.1.1 Scale Enlargement of Ash-Glaze Deposits and Independence of Their Contours

When a localized area of ash-glaze deposits is magnified several times, the originally blurred grain boundaries reveal porous structures resembling volcanic scoria or foam. This magnifying operation makes the opening shapes, wall thicknesses, and interconnection modes of each pore clearly distinguishable. These pore contours can be individually extracted as closed or open graphic units, no longer attached to their original positions of ash accumulation. To put it plainly, this is to enlarge a small nodule formed during firing into a flat graphic image, allowing its edge lines to become the protagonists themselves. Such independent contours can either be used as they are or be simplified by removing internal stray dots while retaining the outermost trending lines[4].

2.1.2 Curve Extraction and Linear Reconstruction of Fire-Mark Boundaries

A transition zone typically exists between the fire marks and the unburned areas, with its boundary taking a wavy or zigzag shape. We extract a segment of this boundary that has pronounced undulating features, isolate it from the original color-layer background, and then convert it into a closed graphic through closure processing. The curvature variation, spacing of protrusions, and depth of indentations along this boundary line all carry velocity information of the flame flow. After linear reconstruction, it can be elongated, compressed, or mirror-reversed to form a set of rhythmically arranged lines. This treatment transforms the trajectory of flame licking into independently placeable linear material.

2.1.3 Morphological Simplification and Unit Categorization of Burst-Stone Pits

Burst-stone pits are cavities left after the expansion and explosion of impurities within the clay body at high temperatures. Their shapes are mostly irregular ellipses, with raised small lip edges around the rims. Simplification removes minor branches or burrs, retaining the main concave contour and the width of the lip edge. Multiple pits of varying sizes on the same object can be classified into three scale levels—small, medium, and large—as distinct unit categories. This categorization enables scattered and random pits to be rearranged and combined like standardized components, for use in constructing regular surface textures.

2.2 Temporal Manifestation through Repeated Superposition and Stratification

2.2.1 Multiple Applications and Density Accumulation of the Same Type of Trace

For the same type of trace, such as smoke stains, we apply them repeatedly to the same area through two or three kiln firings while maintaining similar firing conditions and atmospheres. Each newly added smoke layer partially covers the previous layer; however, due to temperature fluctuations, the coverage is often incomplete, causing the edges of the old layer to faintly show through from beneath the new layer. After multiple rounds of application, the color depth of the area gradually increases, but the blurriness of the edges also rises successively. This density accumulation is not a simple color overlay, but rather leaves irregular uncovered gaps between each layer, forming a breath-like variation in density.

2.2.2 Overlap Order and Interfacial Reaction of Heterogeneous Traces

We apply two types of traces of different natures in sequence, for example, first ash-glaze deposits and then reduction fire marks. During the second firing, the reducing atmosphere not only adds bluish-gray halos to the existing glaze surface but also undergoes interfacial reactions with the first ash-glaze deposits, changing the gloss or even causing slight flaking. Conversely, if fire marks are applied first and then ash-glaze deposits, the latter will cover part of the former and blur them. The overlap order directly determines the legibility of each layer on the surface, and the junction between the two types of traces often produces a third intermediate form.

2.2.3 Selective Appearance of Traces after Masking and Uncovering

Between two firings, we use refractory materials or temporary coatings to mask certain areas, so that the traces from the next firing appear only at the unmasked positions. After we remove the masking, the exposed old traces and newly added traces are juxtaposed, creating a sense of temporal leap. For example, a large area of smoke stains from the first firing is partially covered, and the second firing leaves new melt spots in the covered areas, while the original smoke stains remain only in the unmasked areas. This selective appearance causes two groups of traces from different periods to coexist on the same surface, separated by clear boundaries[5].

2.3 Dialectical Relationship between Uncontrolled Traces and Ordered Forms

2.3.1 Containment of Uncontrolled Traces within Geometric Boundaries

We use clay slabs or molds to produce the surface of the clay body with regular grids, concentric circles, or linear grooves, and during firing we allow uncontrolled traces such as drips, bubbles, or melt holes to occur. The physical presence of geometric boundaries blocks or redirects the uncontrolled traces as they extend to the edges, thereby confining them within the neat cells. The random accumulations inside each cell contrast sharply with the straight boundary lines, and the uncontrolled traces acquire a permitted chaos within the ordered framework.

2.3.2 Embedding of Ordered Strips on Free-Form Surfaces

On curved surfaces where uncontrolled traces such as extensive smoke stains and drips dominate, we use refractory materials to mask several straight strip areas, so that these areas remain light-colored or undamaged after firing. The ordered strips are embedded in the chaotic surface in an interlacing manner, with uniform widths and equal intervals. The edges of the strips often have fine serrations due to incomplete masking, which endows the ordered parts with a hint of uncontrolled traces and provides the eyes with stable reference points.

2.3.3 Alternating Juxtaposition of Uncontrolled Areas and Ordered Grids

We divide the surface of the clay body into multiple sections, and in adjacent sections we alternately use uncontrolled traces and ordered grids as the primary treatment, with frequent alternation —for example, one section is treated with high-temperature drips, while the adjacent section is treated with fine incised lines. The boundaries between sections can be straight, zigzag, or wavy lines. This alternating juxtaposition causes the gaze to continuously switch between randomness and regularity, without either side dominating. The two systems check each other, achieving a visual balance that allows contradictions to coexist.

3. Trace Metaphor and Conceptual Projection of Subjective Consciousness

3.1 Firing Traces as Processual Material Traces

3.1.1 Sequential Coding of Heating and Holding Events on the Surface

Changes in the heating rate leave microcracks or melt patches of different densities on the surface of the clay body. Rapid heating stages tend to produce fine and scattered burst points, while slow heating forms continuous smooth melting zones. The difference in holding duration is reflected in the area and glossiness of the vitrified regions: the longer the holding time, the more fully the melting spreads. These features are superimposed sequentially according to the firing order, forming a sequential coding written on the surface. In other words, the temperature curve is translated into visible lines[6].

3.1.2 Overlap Relationships of Traces and Reverse Deduction of Operational Sequences

The traces produced by a later firing partially overlap those from the previous firing. The boundary morphology of the overlapped areas and the degree of fusion between the old and new traces record the time interval and temperature difference between the two firings. The edges of old traces that are not overlapped tend to retain their complete original forms, while the overlapped parts become rounded or blurred. By observing which layer is on top and which is underneath, one can reversely deduce the chronological order of the operations. This overlapping relationship turns the surface into a stack of compressed layers, each of which retains traces modified by the previous round of fire.

3.1.3 Surface Storage Mechanism of Non-Textual Process Archives

The trace system does not rely on written symbols, but instead stores information through differences in morphology, chromaticity, and texture. The length of a drip can correspond to the duration of an overheating event, and the gray scale of a smoke stain can correspond to the concentration of a reducing atmosphere. The correspondence between these physical parameters is readable, yet it does not need to be translated into language. Viewers can directly perceive the intensity or gentleness of the process from visual differences. This storage mechanism transforms the invisible fluctuations inside the kiln into undulations visible to everyone on the surface of a ceramic piece.

3.2 The Aesthetics of Imperfection and the Conceptual Bearing of Contingency

3.2.1 Visual Refutation of the Concept of Completeness by Crazing and Peeling

Extensive crazing or localized glaze peeling directly disrupts the continuity and smoothness of the object's surface. This disruption is not arbitrary damage, but is caused by the material's own shrinkage stress or by mismatching between glaze and body. Unlike artificial chipping, the edges of fired peeling have a rounded, melted quality, and the cracks often contain secondary microcrystals that have formed within the fissures. These features indicate that the imperfection is a direct product of the firing process, not later damage. When a work fully retains these imperfections, it is stating in its physical condition that completeness is not the only option.

3.2.2 Contingency as an Irreproducible Aesthetic Parameter

The direction of cracking, the shape of peeling, and the density of bubble bursts cannot be precisely predetermined. Creators can create conditions to increase the probability of imperfection, but the final result always retains a margin of contingency. This margin makes each imperfect work unique; even with the same formula and the same kiln position, one cannot obtain identical cracks. Contingency is not an error, but a special parameter that yields only one outcome per firing. Viewers will realize that the work was formed by chance during that particular firing.

3.2.3 Reflection on the Boundary of Control Implicit in Accepting Imperfection

Retaining imperfections means that the creator actively relinquishes complete control over the result; it is not that they cannot achieve regularity, but that they choose not to do so. This choice shifts attention from predetermination toward accepting feedback from the material and the firing conditions, and incorporates such feedback into the work. Imperfection reminds us that there are undesignable parts in the firing process. Accepting these parts is not a compromise, but rather taking the uncontrollable as expressive material; the boundary between control and letting go is marked by the cracks.

3.3 Symbolization of Traces and the Translation of Individual Memory

3.3.1 Isomorphic Correspondence between Radial Cracks and Specific Feelings of Frustration

Radial cracks spread outward from a central point, with spacing increasing from dense to sparse and lines transitioning from deep to shallow, visually conveying a sense of tension being stretched from within. When creators repeatedly employ such cracks and place them at the stress-bearing or visual focal points of a work, these cracks may correspond to the frustration caused by loss of control over the material. The tensile structure of the cracks shares an isomorphic correspondence with the psychological structure of frustration, allowing viewers to read unease from the outward-tearing visual effect.

3.3.2 Repeated Appearance of Low-Saturation Smoke-Stained Layers and the Establishment of Symbolic Identity

Large areas of gray-brown smoke-stained layers with low contrast, blurred boundaries, and no clear directionality, when they consistently appear across a series of works and cover most of the main surface areas, cease to be merely a result of kiln atmosphere and instead become a personal underlying tone. This underlying tone suggests a state of low energy, slowness, or diffusion. Repetition is a direct means of symbolization: a trace appearing once is accidental, but appearing ten times is a choice.

3.3.3 Boundary Control of Translation While Preserving the Origin of Materiality

The symbolization of traces cannot move toward complete symbolic substitution, that is, it cannot turn fire marks into abstract icons unrelated to fire. The boundary of translation lies in the fact that traces must still be identifiable as products of firing, retaining their identity of melting, charring, or cracking. Excessive modification would cause traces to lose their connection with the kiln process, becoming ordinary graphics that can be made with any material. Effective translation, on the premise of maintaining the readability of materiality, allows traces to simultaneously refer to personal experience, so that a crack is both the result of shrinkage stress and the equivalent of memory.

Conclusion

The formal transformation of firing traces begins with the identification of the mechanisms of material generation: dehydration and sintering, bubble and melt holes, and the thermal responses of clay components constitute the material precondition; the directional accumulation of fire marks, the differences in atmospheric color layers, and the graded textures of ash deposits provide visual material; and shrinkage cracking creates tension between controllability and uncontrollability. Above materiality, trace reconstruction achieves visual grammar transformation through abstract extraction, temporal embedding via repeated superposition, and the dialectical relationship between uncontrolled traces and order. These operations further carry conceptual projection, making traces into sequential coding and process archives, enabling imperfection to bear the aesthetics of contingency, and translating individual memory through symbolization. In the future, one may expand to new trace types such as salt firing, combine cognitive neuroaesthetics to quantify viewer responses, or extend toward cross-media creation.

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