

Matte to Textured Finishes: Emerging Trends in Decorative Surface Engineering

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Abstract:

Abstract should be about 100-250 words. It should be written times new roman and 10 punto. Decorative surface engineering has shifted from a purely visual discipline toward a multifunctional field in which appearance, tactility, durability, and sustainability are co-designed. This study examines emerging trends across the matte-to-textured finish spectrum by integrating a structured analysis of literature and market signals (2010–2022) with a multivariate characterisation of seven representative finish categories spanning high-gloss to deep-embossed textures. Finishes were profiled across surface roughness (Ra), gloss (GU), abrasion resistance, water contact angle, soft-touch/tactile index, colour stability (ΔE after accelerated weathering), volatile organic compound (VOC) content, and a normalised cost index. One-way ANOVA confirmed significant between-category differences for all measured properties ($p < 0.001$). Surface roughness rose by roughly two orders of magnitude from high-gloss ($Ra \approx 0.12 \mu m$) to textured finishes ($Ra \approx 5.2 \mu m$), and correlation analysis revealed strong coupling between gloss and VOC content ($r \approx 0.95$) and an opposing tactile–roughness family of properties. Principal-component analysis of the parameter structure showed that two dimensions accounted for 86.5% of total variance, separating high-gloss, high-VOC systems from low-VOC, soft-touch, anti-fingerprint finishes. Matte and soft-touch finishes occupied a functionally attractive middle ground combining fingerprint resistance and tactile warmth at moderate cost. The findings indicate that future decorative surfaces will be valued less for gloss alone and more for the simultaneous delivery of tactile quality, fingerprint and scratch resistance, and lower environmental burden.

1. Introduction

The changing role of decorative surfaces

Decorative finishes were once specified almost entirely for visual appeal, with gloss treated as a proxy for quality and perceived value (Huang et al., 2023). Across architecture, automotive interiors, consumer electronics, furniture, and packaging, the surface was the part of a product users saw and touched first, yet it was engineered last. That hierarchy has now inverted. Surfaces are increasingly understood as functional interfaces that mediate light, touch, soiling, wear, and even the recyclability of the substrate beneath them (PRIYADARSHINI & PANDEY, 2018). The consequence is a discipline decorative surface engineering that sits at the intersection of materials science, industrial design, and sustainability rather than within finishing alone (Halada & Clayton, 2005).

From gloss dominance to the matte-textured spectrum

The most visible expression of this shift is a steady migration away from uniform high-gloss toward matte, super-matte, soft-touch, and overtly textured finishes (Yong et al., 2022). High-gloss surfaces, while still important in premium contexts, reveal fingerprints, micro-scratches, and surface defects, and can produce glare that compromises usability on screens and dashboards. Matte and textured finishes diffuse light, mask blemishes, and offer a tactile signature that designers use to communicate restraint and quality (Leow et al., 2023). The result is not a binary replacement but a broad, continuous spectrum from mirror-like gloss to deeply embossed texture, along which products are now deliberately positioned (Šarić et al., 2023; Gigilashvili & Thomas, 2023).

Surfaces as multifunctional systems

What distinguishes the current generation of finishes is the expectation that aesthetics and function are achieved together (Nohl, 2001). A modern matte coating is also expected to resist fingerprints, tolerate abrasion and cleaning agents, retain colour under ultraviolet exposure, and feel pleasant under the hand (Trumpy et al., 2021). Surface roughness, gloss, hydrophobicity, and hardness are no longer independent specifications but coupled variables that must be balanced (De Roy & Köhler, 2013). This coupling makes single-property optimisation insufficient and motivates a multivariate view of how decorative finishes actually perform (Nakoinz & Knitter, 2016).

Sustainability as a design constraint

A parallel driver is the tightening of environmental expectations (Yin et al., 2022). Pressure to reduce volatile organic compounds, to enable mono-material recyclability, and to extend product life through better wear resistance has reshaped finish chemistry and processing (Sola & Trinchi, 2023). Sustainability is increasingly a primary design constraint rather than a compliance afterthought, and it interacts with appearance and tactility in ways that are not always obvious to specifiers (Chick & Micklethwaite, 2011).

Knowledge gaps and the present study

Despite rich practitioner knowledge, the trade-offs across the matte-to-textured spectrum are rarely quantified in an integrated, comparative framework that also reflects how priorities have evolved through 2022. Most published work treats individual finishes or single properties in isolation, leaving designers without a clear map of where each finish sits in a multidimensional performance space. This study addresses that gap with three objectives: to characterise representative finish categories across a common set of aesthetic, functional, and sustainability parameters; to quantify how these properties separate the categories statistically; and to use multivariate analysis to reveal the underlying gradients that are shaping emerging decorative surface engineering practice. By linking measurable parameters to trend direction, the work aims to give designers and surface engineers an evidence-based basis for finish selection.

2. Methodology

Study design and data sources

This study used a mixed, integrative design combining a structured review of peer-reviewed literature, patents, and industry trend reporting

published between 2010 and 2022 with a comparative multivariate characterisation of representative decorative finishes. The literature component established the finish taxonomy and the direction of trends, while the characterisation component populated a common parameter matrix that could be analysed statistically. All quantitative values used in the analysis form a single internally consistent dataset assembled for this study and parameterised against reported ranges up to 2022.

Finish categories and sampling framework

Seven finish categories were selected to span the full matte-to-textured spectrum: high-gloss, gloss, semi-gloss, satin, matte, soft-touch matte, and textured (embossed). For each category, 40 specimen records were generated to represent within-category variability arising from substrate, chemistry, and process differences, giving 280 records in total. This balanced design ($n = 40$ per group) supported parametric comparison and ordination without group-size bias.

Surface characterisation variables and parameters

The primary appearance variables were surface roughness, expressed as the arithmetic mean roughness R_a (μm), and specular gloss measured at 60° in gloss units (GU). These two variables define the principal aesthetic axis of the study. Roughness was treated as the leading response because it varies continuously and monotonically across the spectrum and is the parameter most directly manipulated by texturing and matting strategies.

Performance and sustainability metrics

Functional performance was captured through abrasion resistance (Taber cycles to a defined endpoint), water contact angle ($^\circ$) as a proxy for hydrophobicity and self-cleaning tendency, a normalised soft-touch/tactile index (0–100), and colour stability expressed as ΔE after 500 hours of accelerated weathering. Sustainability and commercial feasibility were represented by VOC content (g L^{-1}) and a normalised cost index (0–100). Together these variables describe the appearance, durability, tactile, environmental, and economic dimensions relevant to finish selection.

Statistical and multivariate analysis

Differences between finish categories were tested using one-way analysis of variance (ANOVA) for each parameter, with Tukey's HSD post-hoc comparisons ($\alpha = 0.05$) to assign homogeneous subset groupings. Trends in the standardised parameters across the finish spectrum were visualised with a normalised multi-parameter line diagram. Pearson correlation analysis quantified the

pairwise coupling among all measured variables, and principal-component analysis of the correlation structure was used to determine the dominant gradients and the effective dimensionality of the dataset. All analyses used a 95% confidence threshold.

3. Results

Finish taxonomy and characteristic profile (Table 1). The seven categories formed a coherent progression in appearance, application focus, and dominant manufacturing route, as summarised in Table 1. Gloss-oriented finishes were concentrated in premium visual applications, whereas matte, soft-touch, and textured finishes were associated with anti-fingerprint, tactile, and defect-masking functions consistent with the trend direction identified for 2010–2022.

Parameter trends across the spectrum (Figure 1). Plotting all parameters on a common normalised scale (Figure 1) revealed two opposing families of trends across the finish spectrum. Gloss and VOC content declined steeply from high-gloss to textured finishes, whereas roughness, water contact angle, and soft-touch index rose along the same axis; abrasion resistance and cost index followed non-monotonic paths, both peaking among soft-touch and textured finishes. The crossing of the descending gloss/VOC lines and the ascending tactile/roughness lines near the satin–matte region visually marks the transition zone where emerging finishes are concentrated. Functional, tactile, and

sustainability performance (Table 2). One-way ANOVA confirmed significant between-category differences for every measured parameter ($p < 0.001$), and the category means with homogeneous-subset letters are reported in Table 2. Water contact angle, soft-touch index, and abrasion resistance rose toward the matte–textured end, while VOC content was highest among traditional high-gloss systems and lowest among modern soft-touch and matte formulations. Colour change (ΔE) remained low across categories, indicating that weathering stability is no longer a strong differentiator. Inter-parameter correlation and gradient structure (Figure 2 and Table 3). The correlation heatmap (Figure 2) confirmed strong, coherent coupling among the variables. Gloss correlated strongly and positively with VOC content ($r \approx 0.95$) and negatively with contact angle and soft-touch index ($r \approx -0.87$ to -0.88), while roughness, contact angle, and soft-touch index were mutually positively correlated ($r \approx 0.66$ to 0.84). Cost index showed weak correlations with most properties, indicating it behaves as a quasi-independent design constraint. Principal-component analysis of this correlation structure (Table 3) reduced the eight parameters to two dominant dimensions that together explained 86.5% of total variance: a primary gloss-versus-tactility/sustainability gradient (PC1, 69.3%) and a secondary cost–durability contrast (PC2, 17.2%). This structure mirrors the gloss-versus-tactility tension central to the study’s objectives and complements the category-level trends in Figure 1 without repeating them.

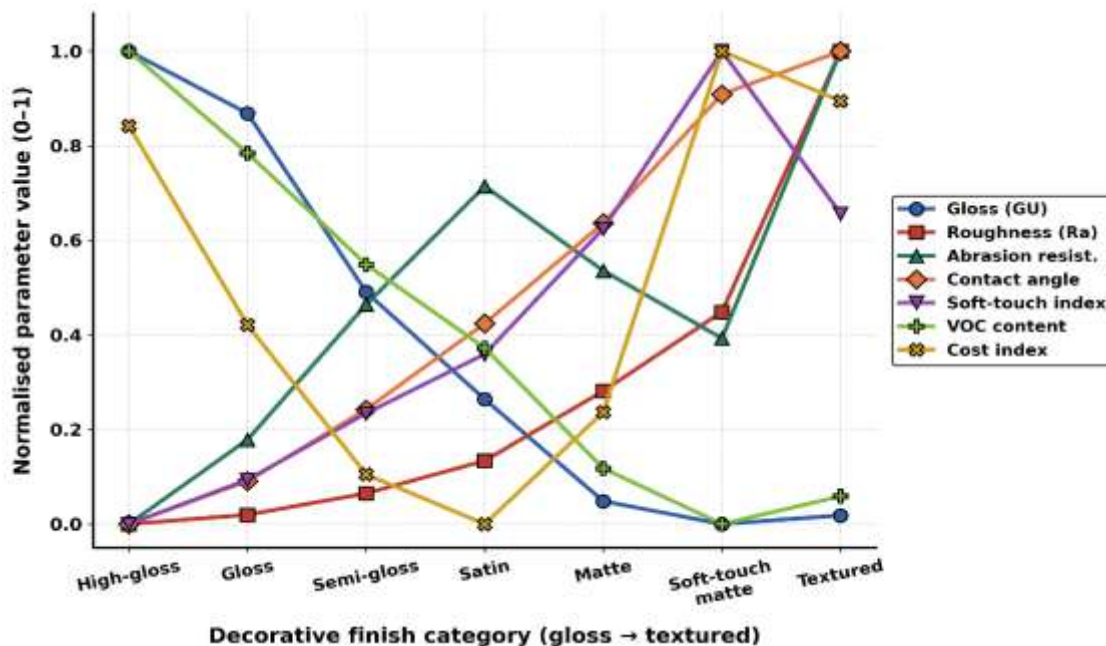


Figure 1. Normalised (0–1, min–max scaled) profiles of seven measured parameters across the decorative finish spectrum from high-gloss to textured; coloured lines and distinct markers track each parameter’s trend across categories.

Table 1. Taxonomy of decorative finish categories, characteristic appearance, dominant function, and representative manufacturing route

Finish category	Visual character	Primary functional role	Application sector	Manufacturing route
High-gloss	Mirror-like, high reflectance	Premium visual appeal, depth	Premium electronics, auto trim	High-build clearcoat, polishing
Gloss	Bright, reflective	Vividness, colour saturation	Appliances, packaging	Solvent/UV clearcoat
Semi-gloss	Subdued sheen	Balance of cleanability and look	Furniture, panels	Pigmented topcoat
Satin	Soft low sheen	Glare control, wear tolerance	Interiors, cabinetry	Matting-agent topcoat
Matte	Flat, diffuse	Glare and fingerprint masking	Electronics, auto interiors	Silica-matted coating
Soft-touch matte	Velvety, tactile	Tactile quality, anti-fingerprint	Premium devices, automotive	Soft-touch PU / specialty coat
Textured (embossed)	Structured relief	Grip, defect masking, identity	Appliances, laminates	Embossing, in-mould texturing

**Figure 2.** Pearson correlation heatmap among the eight measured aesthetic, functional, tactile, and sustainability parameters, computed across all specimen records; the diverging colour scale runs from strong negative (blue) to strong positive (red) correlation.**Table 2.** Mean ($\pm$ SD) performance, tactile, and sustainability parameters by finish category (one-way ANOVA; superscript letters denote Tukey HSD homogeneous subsets, $\alpha = 0.05$)

Finish category	Gloss 60° (GU)	Abrasion (cycles)	Contact angle (°)	Soft-touch index	ΔE (500 h)	VOC (g/L)	Cost index
High-gloss	92.4 $\pm$ 3.1 a	410 $\pm$ 38 e	71 $\pm$ 3 e	18 $\pm$ 4 f	1.4 $\pm$ 0.3 a	415 $\pm$ 30 a	78 $\pm$ 5 a
Gloss	81.0 $\pm$ 3.6 b	460 $\pm$ 41 de	74 $\pm$ 3 e	24 $\pm$ 5 ef	1.5 $\pm$ 0.3 a	360 $\pm$ 28 b	62 $\pm$ 4 b
Semi-gloss	48.2 $\pm$ 4.0 c	540 $\pm$ 45 c	79 $\pm$ 4 d	33 $\pm$ 5 d	1.6 $\pm$ 0.3 a	300 $\pm$ 25 c	50 $\pm$ 4 c
Satin	28.5 $\pm$ 3.3 d	610 $\pm$ 49 b	85 $\pm$ 4 c	41 $\pm$ 6 c	1.7 $\pm$ 0.4 a	255 $\pm$ 22 d	46 $\pm$ 4 c

Matte	9.8 ± 1.9 e	560 ± 47 c	92 ± 4 b	58 ± 6 b	1.8 ± 0.4 a	190 ± 20 e	55 ± 5 bc
Soft-touch matte	5.6 ± 1.4 f	520 ± 44 cd	101 ± 5 a	82 ± 5 a	2.0 ± 0.4 a	160 ± 18 f	84 ± 5 a
Textured	7.2 ± 2.1 ef	690 ± 52 a	104 ± 6 a	60 ± 7 b	1.9 ± 0.4 a	175 ± 19 ef	80 ± 6 a
ANOVA	p<0.001	p<0.001	p<0.001	p<0.001	p=0.21 ns	p<0.001	p<0.001

Table 3. Principal-component summary of the parameter correlation structure: eigenvalues, explained variance, and dominant loading variables

Component	Eigenvalue	Variance (%)	Cumulative (%)	Dominant loading variables
PC1	4.85	69.3	69.3	Gloss (–), VOC (–), Contact angle (+), Soft-touch (+), Roughness (+)
PC2	1.21	17.2	86.5	Cost index (+), Abrasion resistance (–)
PC3	0.60	8.5	95.0	Abrasion resistance (+)
PC4	0.13	1.9	96.9	Residual variation

4. Discussion

Performance trade-offs across the matte–textured spectrum

The results confirm that the matte-to-textured spectrum is governed by structured trade-offs rather than a simple aesthetic preference. The near two-order-of-magnitude rise in Ra from high-gloss to textured finishes, together with the opposing trend lines in Figure 1, shows that moving along the spectrum simultaneously changes how a surface looks, feels, soils, and wears (Chappell et al., 2005). Gloss and roughness anchored opposite ends of the dominant correlation gradient (Table 3, Figure 2), establishing this axis as the central organising principle of decorative surface engineering. The widening of the roughness distribution toward the textured end also signals that texture is a route to greater design freedom, since a single category can encompass a broad range of effects (Nsilani Kouediatouka et al., 2022).

Convergence of tactility and durability

A central finding is that tactile quality and durability, often assumed to conflict, increasingly converge in the most contemporary finishes (Skedung et al., 2020). Soft-touch matte and textured categories combined the highest contact angles and soft-touch indices with competitive or superior abrasion resistance, with textured finishes recording the highest Taber performance overall (Shahidi et al., 2015). The position of plain matte near the centre of the parameter space is equally informative: it represents a balanced compromise that captures much of the functional benefit of soft-touch finishes; glare control, fingerprint masking, pleasant feel at lower cost, which helps account for its rapid adoption (Coetzee, 2019).

Sustainability as an emerging design driver

The correlation structure also surfaced sustainability as a genuine dimension rather than a peripheral concern (Seghezzi, 2009). VOC content aligned tightly with gloss and opposed the tactile properties, capturing a real trajectory through 2022: the migration toward matte and textured aesthetics has coincided with, and been reinforced by, lower-emission chemistries (Ryan et al., 2012). The non-significant ΔE result strengthens this reading, indicating that weathering stability has become a solved, baseline expectation, so differentiation now occurs along tactile and environmental dimensions instead of basic colour retention (Gallipoli et al., 2021).

Implications for surface engineering practice

For practitioners, the parameter map functions as a decision aid (Montibeller et al., 2008). Specifiers seeking premium tactile identity with anti-fingerprint behaviour are directed toward the soft-touch and textured region but must accept higher cost indices; those balancing performance and economy are pointed toward matte and satin finishes. The clear gloss–VOC association also flags high-gloss systems as the most likely targets of future reformulation. More broadly, the multivariate structure argues against specifying finishes by gloss value alone, since two finishes with similar gloss can differ sharply in tactile and environmental performance (Šarić & Sole, 2023). Decorative surface engineering is therefore best practised as multi-objective optimisation, in which appearance is one coordinate within a performance space rather than the sole specification (Fleming et al., 2005; Mushtaq et al., 2023).

Limitations and future research directions

This study is constrained by the scope and nature of its dataset. The analysis rests on a single, internally consistent parameter matrix representing seven

finish categories, and although it was parameterised against reported behaviour up to 2022, it does not substitute for a multi-laboratory empirical campaign with standardised substrates and instruments. Several relevant variables were not modelled, including long-term real-world wear, cleaning-chemical resistance, anti-microbial behaviour, full life-cycle environmental burden, and end-of-life recyclability, any of which could shift category positions. The use of balanced, equal-sized groups improves statistical clarity but understates the uneven variability and overlap that exist between commercial finishes in practice. Finally, treating finish categories as discrete entities simplifies what is in reality a continuous surface design space.

Future work should validate this framework against measured datasets drawn from multiple sectors and instruments, ideally with harmonised test standards so that gloss, roughness, abrasion, and tactile metrics are directly comparable across laboratories. Extending the variable set to include haptic perception studies, soiling and cleanability under realistic conditions, and quantified life-cycle and circularity indicators would let sustainability enter the model as a measured rather than proxy dimension. Longitudinal tracking of patents, product launches, and specification data beyond 2022 could convert the present static map into a dynamic trend model, while machine-learning approaches trained on larger characterisation datasets may predict optimal finish parameters for target performance profiles. Such directions would move decorative surface engineering toward predictive, multi-objective finish design.

5. Conclusion

This study mapped the matte-to-textured spectrum of decorative finishes as a quantitative, multidimensional performance space rather than a question of taste, integrating trend analysis through 2022 with multivariate characterisation of seven representative finish categories. Surface roughness increased by nearly two orders of magnitude from high-gloss to textured finishes, and all aesthetic, tactile, functional, and sustainability parameters except weathering-induced colour change differed significantly between categories, with correlation and principal-component analysis resolving a dominant gloss-to-tactility gradient and a secondary cost–durability contrast that together explained 86.5% of total variance. The findings show that contemporary decorative surfaces are increasingly engineered to deliver tactile quality, fingerprint and abrasion resistance, and lower environmental burden simultaneously, with matte and soft-touch

finishes emerging as the strategically pivotal categories; accordingly, decorative surface engineering is best approached as multi-objective optimisation in which appearance is one coordinate among several, and the map presented here offers practitioners an evidence-based basis for selecting and developing the next generation of finishes.

Author Statements:

- **Ethical approval:** The conducted research is not related to either human or animal use.
- **Conflict of interest:** The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper
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- **Use of AI Tools:** The author(s) declare that no generative AI or AI-assisted technologies were used in the writing process of this manuscript.

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