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More Than a Visual Element: Colour as a Transdisciplinary Knowledge and Competence Framework for Design

ABSTRACT

Colour is everywhere in design, and yet design education has not kept pace with what colour does in contemporary practice. Across the discipline, colour continues to be framed primarily as a visual element: something applied to a design, concerning aesthetics and composition, addressed once the more consequential decisions have been made. This paper argues that this framing is too narrow, and that its narrowness carries consequences for practice, for education, and for the capacity of design to respond to the challenges it now faces. Colour decisions in contemporary design extend well beyond the palette, into ecological impact, cultural specificity, accessibility and inclusion, and AI-assisted production, among others. In each of these domains, design is already making colour decisions of consequence without necessarily recognising them as colour decisions. The paper presents a framework for colour competence in design, developed across seventeen years of doctoral and post-doctoral research and teaching, and organised into four knowledge domains: Colour Context and Strategic Framing; Colour, Human Experience and Inclusion; Colour Decision and Materialisation; and Colour Performance and Impact. Aligned with the Double Diamond model of the design process, and structured across two dimensions, stable knowledge domains and the five capacities of colour literacy that operate across them, the framework functions as a map of the territory colour actually occupies in design practice. The paper argues that accountability, one of those five capacities, is the competence the framework makes operable: a designer can account for a colour decision only by knowing which domains of colour knowledge it draws upon, and by which ways of knowing.

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1. Introduction

Every designed object, environment, and communication has colour. It is physically inescapable, the result of how light interacts with every material surface a designer specifies, every screen a designer composes for, every space a designer shapes. And yet colour is one of the design domains that operates with the least disciplinary accountability, the least explicit knowledge, and the least sustained preparation (Bantom, 2006; Csillag, Lupinacci & Hirschler, 2018; Mottram, 2018; Calvo Ivanovic, 2022).

Colour is everywhere in design, and in design it is largely unexamined. This paper takes that paradox as its point of departure and proposes a framework for addressing it.

The paradox has a structural cause. Across the design discipline, colour has been classified as a visual element: a compositional unit, alongside form, line, and texture, that is applied to a design and that concerns aesthetics. This classification is so deeply embedded in design education and practice that it operates as common sense rather than as a choice that could be otherwise.

Its consequences are visible in the curriculum. In most design programmes, colour is encountered early and briefly, concentrated in a first-year foundational course, most often through exercises in perceptual relationality inherited from Albers's (1963) Interaction of Color . These exercises are valuable: they train the eye to see that colour is relational and context-dependent. But they were never designed to constitute a complete colour education for a designer, and in most curricula they are followed by little or nothing. The designer then meets colour again in professional practice as a finishing tool, a decision made once the form, the function, the material, and the user have already been settled. Several scholars have documented the marginal position of colour in design and architecture education over the past three decades (Calvo Ivanovic, 2024).

The problem, however, is not simply that colour is taught too little. It is that the discipline has misclassified what colour is. Recent work in colour and design education has proposed that colour is more accurately understood not as a visual element that design contains, but as a form of infrastructure within which design operates (Calvo Ivanovic, 2026). The reframing draws on Susan Leigh Star's analysis of infrastructure, which identifies properties characteristic of infrastructural systems: they are embedded in everything they make possible; they recede from notice while functioning; they are learned as part of membership in a community of practice; and they become visible only when they break down (Star, 1999). Colour exhibits each of these. It is embedded in every designed artefact; it is invisible when it works, so that a user experiences the product, the space, or the message rather than "the colour of" it; it is acquired through membership in particular communities of practice, so that a textile dyer, a colour scientist, and a film colourist each know a different colour; and it becomes conspicuous precisely when a colour decision fails.

Contemporary design practice is producing such failures with increasing frequency and visibility. Consider four brief instances, each of which this paper will return to. First, the ecological: textile dyeing alone accounts for approximately 20% of global water pollution, and up to 80% of a product's environmental impact is determined by decisions made at the design stage, among them the choice of colourants and their material behaviour (European Parliament, 2020; Murzyn-Kupisz & Hołuj, 2021). Second, the cultural: colour decisions that presuppose universal meaning misfire when deployed across cultural contexts, as when a global beverage brand's colour choice communicates celebration in one market and mourning in another (Madden, Hewett & Roth, 2000). Third, the accessibility of colour-coded systems: wayfinding schemes that rely on colour alone fail the approximately 8% of men and 0.5% of women with colour vision deficiency, and fail further under the lighting conditions and among the ageing populations of the environments in which they are actually used (Mollon, 2003). Fourth, the algorithmic: generative AI image systems reproduce systematic colour biases, with one 2025 study finding that widely-used models generated dermatological images featuring light skin tones in nearly 90% of cases (Joerg et al., 2025).

These are not isolated failures of individual judgement. They are the visible surface of a structural condition: colour decisions of real consequence are being made across the full arc of contemporary design practice, by practitioners who have not been prepared to recognise them as colour decisions, and who therefore make them without the knowledge those decisions require. The remedy cannot be simply more colour content added to an already crowded first-year course. What the discipline needs is a map of the territory colour actually occupies, one that can orient educators and practitioners to the domains in which colour competence is required, and that can locate where in the design process each domain is called upon. This paper presents such a map. It sets out a four-area framework for colour competence in design, describes the developmental history and epistemological commitments that underpin it, introduces the cross-cutting capacities that operate across its four domains, and argues that accountability, one of those capacities, is what the framework finally makes operable.

2. A framework for colour competence in design

2.1. Origin, development and epistemological grounding

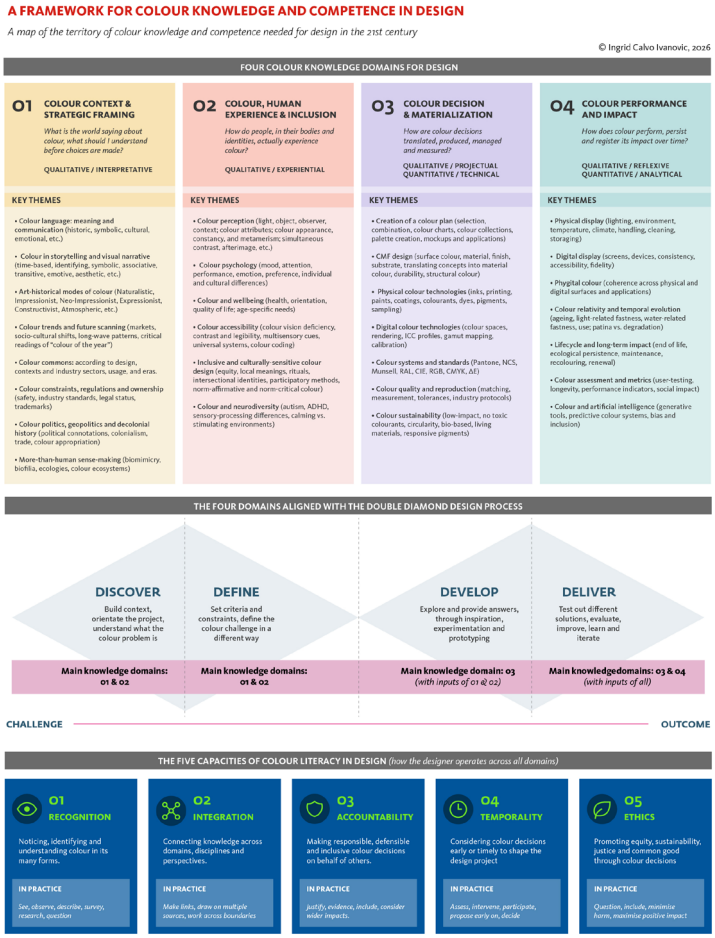
The framework presented here (Figure 1) did not arrive fully formed. It is the product of seventeen years of research and teaching in colour for design, and it has evolved substantially. Its first articulation appeared in the author's doctoral thesis (Calvo Ivanovic, 2022), which, on the basis of a literature review of where and when colour decisions occur in the design process, identified four phases of colour decision-making: a Conceptual phase, concerned with colour meaning, association, and selection; a Human Factors phase, concerned with perception, psychology, and the human response to colour; a Manufacture phase, concerned with the material and technical realisation of colour; and an Exhibition phase, concerned with how colour is displayed and perceived in its final context. This first version, grounded in the literature, mapped colour decisions onto the temporal sequence of a design project and demonstrated that colour is not confined to a single moment but recurs throughout.

As the author socialised this version through international presentations, workshops, and teaching, and developed it through practice, two limitations became

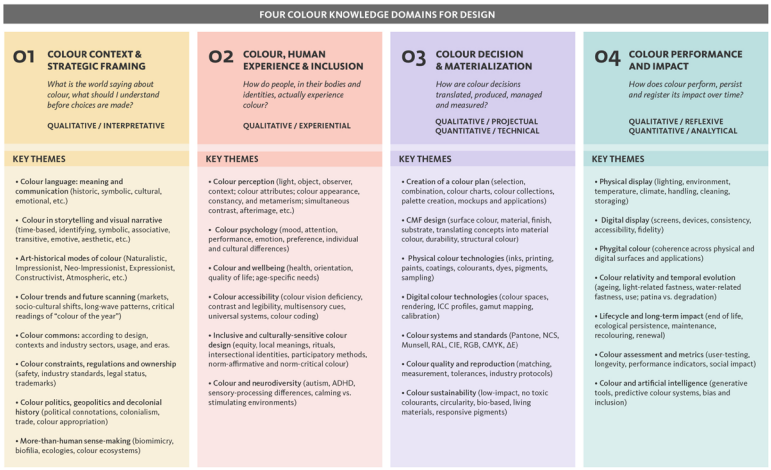
evident. The first was conceptual. The phase-based labels described when colour decisions occur rather than what kind of knowledge they require. A phase is a moment in a sequence; but the difficulty designers face with colour is not primarily one of timing, it is one of knowledge. What a designer needs is not to be told that colour decisions happen at the conceptual stage, but to understand what body of knowledge a colour decision at that stage draws upon, and what it would mean to make it well. The second limitation was one of completeness: as the author's understanding developed through further research and practice, the original four phases proved too narrow to accommodate the full range of contemporary colour concerns, from sustainability and cultural specificity to algorithmic mediation and neurodiversity.

The current version responds to both. It reconceives the four phases as four domains of colour knowledge and competence, renamed to foreground the domain of knowing rather than the stage of the process: Colour Context and Strategic Framing; Colour, Human Experience and Inclusion; Colour Decision and Materialisation; and Colour Performance and Impact (Figure 2). This shift, from phases to domains, is the framework's central conceptual move. It transforms the framework from a description of a sequence into a map of a territory. A phase is something a project passes through and leaves behind; a domain of competence is something a designer inhabits and returns to. The re-conception also allows each domain to expand well beyond its original phase content, to encompass the strategic, cultural, ecological, ethical, and inclusive dimensions contemporary colour decisions require. In its development beyond the doctoral version, the framework is author-derived, grounded in research, teaching, and professional practice rather than in a single systematic study; its validation through teaching and application is ongoing work. The framework models colour as an accountable decision made by a designer, on behalf of others, within a design process, which is also the boundary of its scope: artistic colour practice, answering to no brief and no external accountability, and colour as a primary product in its own right, as in a colour-forecasting house or a paint manufacturer's range, draw on the same bodies of knowledge but lie outside the decision model the framework describes.

Two structural properties govern how the framework should be read. The first concerns ways of knowing. The four domains do not all rest on the same kind of knowledge, and they do not divide evenly between



» **Figure 1:** *Overview of the Framework for Colour Knowledge and Competence in Design*

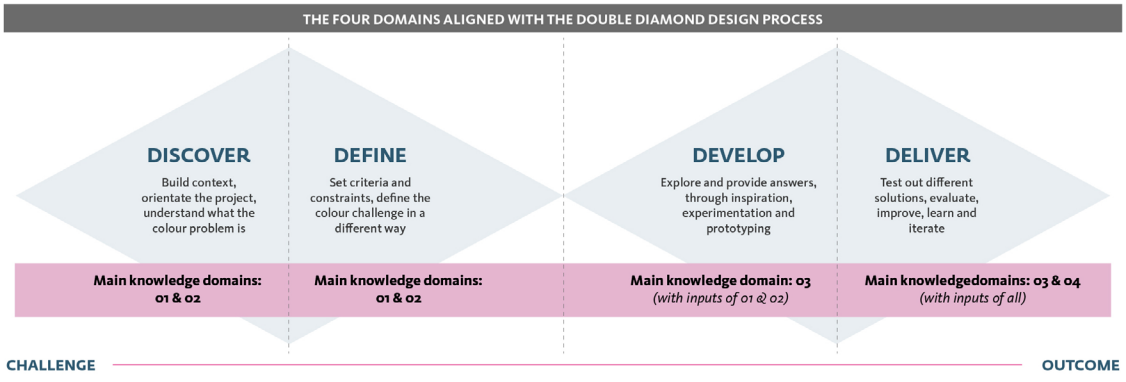


» **Figure 2:** *The four colour knowledge domains for design. Each domain names the question it addresses, the ways of knowing it draws upon and presents its main themes*

kinds. The first two domains are predominantly qualitative, but in distinct registers: Area 01 knows colour interpretatively, through cultural reading, historical understanding, and strategic analysis, while Area 02 knows it experientially, through perceptual, psychological, and participatory inquiry into how colour is lived in the body and in communities. The second two domains are each dual. Area 03, where a colour is decided and made, joins a projectual way of knowing — the designerly act of composing a palette and conceiving a colour-material-finish — to a technical, quantitative one: colorimetry, standardised colour systems, measurable tolerance. Area 04, where colour performs and registers its impact, joins an analytical way of knowing — the measurement of display, durability, and change — to an evaluative one: the qualitative assessment of how colour is received, and whether it does what it was intended to do, once real people live with it.

This division is not incidental, and it maps onto the structure of the design process itself. The four domains are aligned with the Double Diamond model of the design process (Design Council, 2021), a widely-used articulation of design as a movement through Discover, Define, Develop, and Deliver (Figure 3). The alignment is deliberate but loose. It does not claim that colour decisions must follow a fixed order; it indicates where in the design process each domain is most actively called upon, while recognising that any domain may be relevant at any point. The alignment makes the framework legible to designers who already use the Double Diamond, and situates colour competence within the process of design rather than alongside it.

The challenge space of the first diamond, Discover and Define, is navigated qualitatively, by interpretation and lived experience; the outcome space of the second, Develop and Deliver, demands the qualitative and the quantitative together, because making a colour real, and accounting for its life in the world, cannot be done in either register alone. This is not a hierarchy, and it is not an admission that some domains are better evidenced than others. It reflects a genuine plurality in how colour is known, one the colour research community has increasingly come to recognise, moving from an earlier period in which quantitative measurement was treated as the only fully legitimate form of colour knowledge, toward a contemporary understanding in which experiential, practice-based, and situated ways of knowing are acknowledged as equally valid and equally necessary (Calvo



» **Figure 3:** *The four-domain framework for colour competence in design, aligned with the Double Diamond model*



» **Figure 4:** *The five capacities of colour literacy operate across all four, with accountability foregrounded*

Ivanovic, 2026). Colour literacy, on this account, is not competence in one way of knowing but the capacity to move appropriately between several of them. A designer who can measure the difference of two colour samples to a ΔE tolerance but cannot interpret its cultural meaning, or a designer who can interpret its cultural meaning but cannot specify it for production, are each colour-literate in one register and illiterate in another. The framework holds both, and insists that both are required.

The second structural property is that the framework operates across two dimensions. The four domains are one dimension: they describe what a colour decision touches, and, as argued below, they are structurally stable. The other dimension consists of the five capacities of colour literacy that operate across all four domains (Figure 4): recognition, integration, accountability, temporality, and ethics (Calvo Ivanovic, 2026). These describe how a designer operates within the territory the domains define, and, unlike the domains, they are historically contingent in their emphasis. This two-dimensional structure is developed in Section 2.7; it is noted here because it shapes everything between. Accountability, the capacity this paper foregrounds, belongs to this second dimension: it is not a domain but a way of operating across all of them.

The four knowledge domains are described in turn below. Each represents a distinct territory of colour knowledge, with its own body of evidence, its own methods, its own vocabulary, and its own standards of accountability. A designer is unlikely to hold equal depth across all four; a printing specialist will dominate the third domain more than the first, just as a brand strategist will command the first more fully than the third. But a colour-literate designer is one who is aware that all four domains exist, who can recognise when a decision draws upon a domain outside their depth, and who knows how to seek the knowledge that decision requires.

2.2. Colour context and strategic framing

The first domain concerns the strategic and cultural foundations of colour decisions. It is most active during the Discover phase, when the designer builds context, orients the project, and establishes the intellectual and cultural territory within which colour decisions will be made. It asks: what is the world saying about colour, and what should I understand before any choice is made? Its characteristic way of knowing is qualitative and interpretive, drawing on the humanities and social sciences rather than on measurement. Crucially, this domain treats culture as external context to be researched, knowledge about the world that informs a decision, a framing that distinguishes it from the second domain, where culture appears as lived human difference to be included.

At its core is colour language: meaning and communication: how colour carries meaning across symbolic, cultural, and emotional registers, and how those meanings shift across geographies, communities, and histories. Here a designer learns that colour associations are not universal facts but cultural conventions, and develops the interpretive capacity to establish what a colour communicates in a given context rather than assuming a shared meaning. Closely related is colour in storytelling and visual narrative, the ways colour operates as a narrative device: performing distinct functions that include the time-based (marking periods, flashbacks, or the passage of time), the identifying (distinguishing characters, brands, or elements), the symbolic and associative (carrying thematic meaning), the transitive (guiding the eye and signalling change), the emotive and aesthetic (setting mood and tone), and the audio-visual and communicative (operating alongside sound and motion). It also encompasses the major art-historical modes of colour in image-making, each offering a distinct logic that contemporary visual designers continue to draw upon, often without naming it: the Naturalistic (colour as the faithful description of the observed world, the local colour of things as they are), the Impressionist (colour as the record of perceived light, dissolving local colour into the atmosphere that falls on it), the Neo-Impressionist (colour as optical mixture, the divided, systematic juxtaposition of pure tones that fuse in the eye and exploit simultaneous contrast deliberately), the Expressionist (colour as the vehicle of emotion and subjectivity, released from description altogether), the Constructivist (colour as structural and functional element, assigned a job rather than a mood), and the Atmospheric (colour as the carrier of depth and distance, the

cooling and desaturation of receding planes). These are not historical curiosities. Each survives as a living logic in contemporary design: the Naturalistic and Atmospheric wherever colour renders a world and situates the eye within it, in cinematography, environmental and spatial design, and photographic grading; the Impressionist and Neo-Impressionist wherever colour is treated as light and optical event, in screen-based and generative image-making; the Expressionist in any deliberately heightened palette chosen for emotional charge, in branding, title sequences, and editorial illustration; and the Constructivist wherever colour is given a structural task, coding information, organising a layout, distinguishing zones in an interface, a building or a transit map. A designer who can name which logic a project calls for is making a more deliberate and more defensible colour decision than one working by untheorised preference.

Adjacent to these is colour trend and future scanning: tracking colour change over time and anticipating its directions, and, critically, distinguishing the genuine cultural and social signals in colour movements — through market cycles, socio-cultural shifts, and long-wave historical patterns — from their commercial orchestration. The annual "colour of the year" phenomenon is frequently received as cultural insight when it is more accurately understood as a commercial product; a designer competent in this domain reads such phenomena critically rather than simply following them (Calvo Ivanovic, 2025). This attention to the collective movement of colour leads directly to a further concern of the domain: colour decisions do not stay singular. They aggregate, through shared tools, trends, and markets, into the colour commons — the collective colour languages of a sector, an industry, or an era. A strategically and ethically literate designer is aware of the contribution each decision makes to this shared resource, and not only to the individual artefact, and reads the commons of their field as part of understanding what the world is already saying about colour. The domain also sets out what the world requires of a colour decision before it is free to be made. Many colour decisions are not open at all but prescribed, through colour constraints, regulation, and ownership: mandated safety colours, industry and regulatory standards, and the legal status of colour itself, including trademarked and protected colours a designer may not use and may wish to establish. The competence is to research and surface these early, in the Discover phase, rather than to discover them after a decision has been made. The domain includes colour, geopolitics, and decolonial history, which recovers the ways colour history has been shaped by colonialism, trade in dyes and pigments, and cultural appropriation — an aspect of colour knowledge that design education has largely omitted and that a responsible practice increasingly requires. And it extends, at its outer edge, to more-than-human sense-making, which asks how colour functions beyond human perception, drawing on biomimicry and the study of ecological colour signalling, the pigment and pattern strategies of other species, and the chromatic logic of habitats and ecosystems, as sources of design knowledge and inspiration. Treated as applied inquiry rather than speculation, it offers designers a repertoire of colour strategies refined over evolutionary time.

2.3. Colour, human experience and inclusion

The second domain concerns colour as a dimension of human experience: the perceptual, psychological, physiological, and social registers through which colour is received and responded to. It is most active at the transition from Discover to Define, as the designer deepens understanding of the people for whom they are designing and translates it into criteria and constraints. It asks: how do people, in their bodies and identities, actually experience colour? Its characteristic way of knowing is qualitative and experiential, though it draws also on the empirical evidence of perceptual and health science. Where the first domain treats culture as external context to be researched, this domain treats culture as lived human difference to be included, the situated experience of specific people who must be designed with rather than for. The first is epistemic; the second is ethical and participatory. A study of how the red hue family communicates across cultures belongs to the first domain; designing a colour system with and for a particular community belongs to the second.

The domain begins with colour perception: how colour is physically and cognitively processed, including the interdependence of light, object, observer, and context, the phenomena of colour constancy and metamerism, and the relational instability of colour in interaction, where adjacent colours alter one another through simultaneous contrast and afterimage. It extends to colour psychology in its empirically grounded form, distinguished sharply from the universal hue-based symbolism that circulates through popular discourse: the evidence shows that colour's effects on mood, attention, performance, and emotion are real but are strongly mediated by lightness and saturation as well as hue, by context, and by individual preference and cultural difference. It includes colour and wellbeing: how colour in built environments affects health, orientation, and quality of life, with particular attention to age-specific needs and to supportive environments in healthcare and care settings. It encompasses colour accessibility: colour vision deficiency and its design implications, legibility and contrast, multisensory colour cues, universal and safety-colour systems, and the principle of redundant coding, in which colour information is usually paired with a second channel so that no user depends on colour discrimination alone. Two phenomena from this domain deserve emphasis because they are routinely underestimated in practice. The first is the sheer

prevalence of colour vision deficiency, which affects roughly one in twelve men: a colour decision that relies on distinguishing red from green is, in effect, a decision that a significant fraction of the audience will misread, which is why redundant coding, adding a pattern, a label, a shape, or a position to carry the same information, is not an optional accommodation but a baseline of competent colour design. The second is metamerism, the phenomenon by which two colours that match perfectly under one light source diverge visibly under another. A pair of materials specified to match in the studio may fail to match in the showroom, the street, or the hospital corridor, with real consequences for products assembled from differently-sourced components. Both phenomena reward the same disposition: treating the perceiving human, in the actual conditions of use, as the final arbiter of a colour decision, rather than the designer's eye in the controlled conditions of the studio.

It contains inclusive and culturally-sensitive colour design: the practice of designing colour for equity and participation, centring marginalised and underserved communities, attending to local colour meanings and regional palettes, to rituals and customs, and to intersectional and hybrid identities, and working through participatory decision-making rather than imposing a dominant colour standard. It admits both norm-affirmative approaches, which work within a community's existing colour conventions, and norm-critical ones, which challenge inherited defaults, and it draws on affective-measurement methods to understand subjective and emotional responses to colour across diverse groups. And it now includes colour and neurodiversity: the design of colour for autistic people, people with ADHD, and those with sensory-processing differences, attending to sensory overload, to neurodivergent colour preference, and to the difference between calming and stimulating colour environments, a significant and underserved territory in both practice and education.

2.4. Colour decision and materialisation

The third domain concerns the transformation of a colour decision into realised form — physical, digital, or a hybrid of the two. It is most active during the Develop phase, the period of decision, prototyping, specification, and technical resolution in which colour moves from intention to outcome. It asks: how are colour decisions translated, produced, managed and measured? This is the domain where the two ways of knowing the framework insists upon are not merely both present but inseparable. It joins a projectual way of knowing — the designerly act of composing palettes and conceiving how colour will meet material and surface — to a quantitative, technical one: the colour science, measurement, and standardisation through which a decision either survives the journey to the finished artefact or is lost in translation. It is where the designer's responsibility for a colour decision meets the material and technological reality of what can actually be produced. Precisely because it holds both registers at once, it is the clearest demonstration in the framework that a decision made well and a decision made real are two faces of a single competence.

At the point of decision is the colour plan: the concrete, specified set of colour choices the designer commits to and will hand over, expressed through colour selection, colour charts and collections, palette creation, and application of colours across the designed artefact and its mock-ups. Central to the colour plan is colour combination: the relational craft of deciding which colours sit together, in what proportion and arrangement, to form a working palette. This paper deliberately declines the traditional vocabulary of "harmony" and "contrast" to name this craft, because those terms carry — and have carried into generations of design teaching — the misconception that colour combination is governed by the attribute of hue only, and fixed rules of correct and incorrect pairing (Colour Literacy Project, n.d.; Calvo Ivanovic, 2026). Combination is better understood as a situated, intentional act of composition, answerable to the project rather than to a rulebook. Its perceptual basis — how adjacent colours alter one another through simultaneous contrast, vibration, and the relational instability demonstrated by Albers (1963) — is knowledge held in Area 02; what belongs here, in the colour plan, is the designer's act of deciding and specifying the combination itself. The colour plan is where the designer's reasoning across all four domains becomes a tangible, defensible artefact; it is, in a precise sense, accountability made material — the palette as the justification rendered concrete and ready to go into the world.

The decision becomes material through CMF design — Colour, Material, and Finish — the practice in which colour specification is inseparable from material selection and surface treatment. The appearance and behaviour of a colour depend on the substrate that carries it, on its finish and texture, and on its performance against fade, wear, humidity, UV exposure, and ageing. This theme includes the systematic study of surface behaviour, sometimes approached through frameworks such as CESIA, and the phenomenon of structural colour — colour produced by physical microstructure rather than pigment, as in iridescence and certain structural blues. It is given material existence through the physical colour technologies — inks and printing, paints, coatings, colourants, dyes, and pigments, and the practice of colour sampling — and through the digital colour technologies — colour spaces, rendering, ICC profiles, gamut mapping, calibration, and colour management — which determine whether a colour decision is reproduced faithfully from screen to output and across the devices and production chains that carry it.

These technologies are governed by shared colour systems and standards — the Pantone Matching System, NCS, Munsell, RAL, the CIE colour spaces, the RGB and CMYK models, and the ΔE colour-difference metric — the languages through which colour is specified and communicated across the production chain, varying by region and industry. And they are held to account through colour quality and reproduction: colour matching, instrumental and visual assessment, colorimetric measurement, and ΔE tolerance management, through which fidelity is verified and each industry defines the limits of acceptable difference. It is worth making this concrete, because it is the bridge from which the framework extends. The ΔE metric expresses the perceived difference between two colours as a single number: a ΔE of roughly one marks the threshold of a just-noticeable difference under controlled conditions, a ΔE below one is generally imperceptible, and the number grows as two colours diverge. Different industries set their acceptable tolerance accordingly, and the choice is an economic and perceptual judgement as much as a technical one: a premium automotive finish, where a visible mismatch between a body panel and a bumper would read as a defect, may demand a tolerance near ΔE one; whereas a printed textile, where the eye is more forgiving and the production process less controllable, may accept a ΔE of several units. The colour-literate designer understands not only how to read such a number but why the tolerance differs between a car door and a cotton shirt, and can therefore specify colour in a way the production chain can actually deliver. This is quantitative colour knowledge in its most developed form; and it sits, in this domain, alongside the projectual judgement of the colour plan, so that Area 03 holds the two ways of knowing in a single working relationship. The rigour designer, in collaboration with other professionals, brings to ΔE, is precisely the standard the framework asks the other domains to match in their own registers.

Finally, the domain carries colour sustainability at the point of production: low-impact colourants, circular approaches to colour, durability and repairability, and the emerging fields of bio-based and living colour materials, and of active or responsive pigments — thermochromic, photochromic, UV-reactive, time-based or photodegradable, and electrochromic — that change with temperature, light, or time. Sustainability is not a separate concern bolted onto production but a dimension of every material and technological choice the domain makes, and it is where the ecological consequences of a colour decision are first determined, before they are later observed in use.

2.5. Colour performance and impact

The fourth domain concerns what colour does after it enters the world: how it performs over time, in real environments, for real people, and with consequences the designer must anticipate before they can be observed. It is most active during the Deliver phase, and its subject matter extends well beyond it, into the in-use life of the artefact — which means the domain is often drawn upon anticipatorily: at the moment of delivery the designer is already reasoning about a performance that will only unfold over the months and years after the project closes. It asks: how does colour perform, persist, and register its impact over time? Its ways of knowing are dual — an analytical, quantitative measurement of display, durability, and change, and an evaluative, qualitative assessment of how colour is received and whether it achieves what it was designed to achieve. The intended emotional impact of a colour, and its influence on behaviour, are not decided here; they are formed in the first and second domains, on the basis of cultural framing and human understanding, and the colour that carries them is decided and specified in the third. What this domain does is test those intentions against reality: it is the site of evaluation, not of origination.

It encompasses physical display: how a colour is perceived under the specific lighting, spatial relationships, and surrounding colours of its actual environment, which may differ markedly from the studio, and how it responds to natural and artificial light, temperature and seasonal shifts, storage, handling, cleaning, and climate. It includes digital display: the performance of colour across screen technologies and devices, cross-device consistency, colour accessibility in user interfaces, and the constraints of gamut. And it now includes phygital colour: the coherence of colour across physical and digital surfaces experienced together, as in a product and its companion application, or a printed artefact and its augmented overlay, highly relevant today for e-commerce and online purchasing. Phygital coherence belongs here, rather than with the production technologies that achieve it, because it is ultimately a question of performance in experience — whether the colour reads as one and the same across the surfaces a person encounters in use — and it is verified, like everything else in this domain, against the world rather than in the studio.

It contains colour relativity and temporal evolution: how colour evolves as materials age and are exposed to light and use; how designed colour change may be valued as a quality, as in materials designed to patina, or mismanaged as a failure; and how designing for colour evolution requires competences distinct from designing for stability. This temporal dimension is one the discipline is least trained to consider, because design education and design representation both favour the fixed, finished image — the render, the mock-up, the swatch — over the artefact as it will actually look after a year, a decade, a lifetime of weather and use. Yet almost every physical colour decision is in truth a decision about a trajectory: a façade colour is a decision about how a building will look as its coating chalks and fades; a naturally dyed

textile is a decision about how a garment will soften with washing; a patinating metal is a decision to let the material write its own colour over time. A designer competent in this domain decides not only the colour of the thing at the moment of delivery but the colour of its whole life, and can tell the difference between an evolution that enriches an artefact and a degradation that ruins it. It encompasses the lifecycle and long-term impact of colour decisions in use: the fate of coloured materials at end of life, the ecological persistence of dyes and pigments, the legibility of visible recycled colour, strategies of maintenance, recolouring, and renewal that reward care over replacement, and the reception of colour over time within the communities that inhabit it.

It contains, too, colour assessment and metrics, the under-developed but essential question of how the success of a colour decision is actually measured: user-testing protocols for colour, longevity benchmarking, colour performance indicators in brand strategy, and social-impact assessment, including the evaluation of whether the emotional and behavioural effects a colour was designed to produce are in fact produced once it is experienced by real people. Without this evaluative competence, colour decisions cannot be judged against evidence, and the discipline cannot accumulate knowledge about which colour decisions succeed and why.

Finally, and most recently, the domain has come to include colour and artificial intelligence, placed here because the most consequential questions AI raises about colour are questions of impact. Generative tools that produce palettes and images, and predictive systems that anticipate colour directions, are increasingly the instruments through which colour is delivered; but their most far-reaching effect is systemic. The datasets on which these tools are trained encode cultural and racial biases, and because the tools operate at scale, they reproduce those exclusions across countless outputs at once, registering an impact on the colour landscape far larger than any single decision. Treating colour and AI as a matter of performance and impact, rather than of production technique alone, keeps the designer's attention on the right question: not only what the tool can make, but what — cumulatively, and across whole populations of users — it brings into the world.

2.6. Two dimensions: stable domains and the capacities that operate across them

The four domains are only one dimension of the framework. Operating across all of them is a second dimension: the five capacities of disciplinary colour literacy (shown in Figure 4), recognition, integration, accountability, temporality, and ethics (Calvo Ivanovic, 2026). These are not themselves domains of knowledge but ways in which the designer operates within the territory the domains define. Recognition is the capacity to see when a design decision is also a colour decision. Integration is the capacity to draw on the relevant knowledge domains, and on the contributing disciplines and research methods behind them, without being expert in all of them. Accountability is the capacity to justify a colour decision, which includes being able to name, document, and communicate it, since a decision that cannot be articulated cannot be justified. Temporality is the capacity to make colour decisions early enough to shape the design rather than merely finish it. And ethics is the recognition that colour decisions are made on behalf of others who must live with their consequences. Colour research methods and colour communication, sometimes treated as separate competences, are better understood as integral to these capacities: research is how integration and accountability reach their fullest expression, the production of colour knowledge rather than its mere application, and communication is accountability made external.

The distinction between the two dimensions is not merely organisational; it is a claim about how the framework relates to time. The four knowledge domains are proposed as structurally stable, and are an attempt to exhaust the dimensions of a colour decision in design. They are defined by what a colour decision necessarily touches: the world it enters, the people it is for, the matter it is made of, and the consequences it produces over time. The five capacities, by contrast, are historically contingent in their emphasis. They are exercised differently, and weighted differently, as the needs of design change. Accountability is foregrounded now because the present moment, with its ecological, cultural, inclusive, and algorithmic pressures, makes the justification of colour decisions unusually urgent; a different moment may foreground a different capacity.

The relationship between the two dimensions is dynamic, and it is worth stating as the framework's central hypothesis about its own evolution. When a new design condition arises, it registers first as a new demand on the capacities, a new way the designer must operate, which practice suddenly requires. The arrival of generative AI in mainstream design is a clear instance: it created, almost overnight, an intensified demand on accountability, the need to verbalise colour precisely, and on integration, the need to understand how models handle colour and encode bias. That demand is cross-cutting; it operates across every domain. But to meet it, designers need knowledge that did not previously sit clearly in any domain — how diffusion models process colour, how corpora encode chromatic bias — and that knowledge is then absorbed into the existing domains: the systemic, cultural, and racial bias these tools reproduce settles into Area 04, as a question of colour's impact at scale, informed by the human and cultural understanding of Areas 01 and 02, while the demand to verbalise colour precisely settles into the practice of decision and speci-

fication in Area 03, where the colour plan is composed and made. The capacities, in other words, are the framework's leading edge, where new needs first register; the domains are its slower-moving structure, which absorbs the new knowledge those needs demand. This is how the framework has already grown: sustainability, neurodiversity, decolonial history, and algorithmic colour all entered as new demands and were absorbed into the four domains without requiring a fifth. The hypothesis on which the framework rests is that this absorption will continue: that emerging demands will enrich the domains, including by bringing new ways of knowing into them, rather than requiring the domains themselves to multiply. This is offered as a design hypothesis rather than a law; should future research reveal a colour concern no existing domain can absorb, the framework would need revision. But its structure is deliberately built to make such revision rare, by carving the domains at the joints of what a colour decision fundamentally is. For instance, one specific body of practice — colour in service and experience design, the sustaining of colour coherence across the many touchpoints of a designed service — is best understood not as a domain or a capacity but as a context in which all four domains and all five capacities are exercised together.

3. Accountability: the capacity the framework makes operable

Of the five capacities, one has a special relationship to the framework, and it is the focus of the remainder of this paper: accountability. A recent account defines disciplinary colour literacy as the full set of five, and situates accountability among them as the capacity to answer the question why this colour? with reasoning grounded in evidence and context, to the standard the discipline routinely applies elsewhere (Calvo Ivanovic, 2026). It is worth dwelling on how unusual the absence of this standard is. In design education and practice, decisions the discipline takes seriously are decisions it expects to see justified. A student who selects a material, specifies an ergonomic feature, or chooses a typeface is expected to explain the choice: what informed it, what alternatives were weighed, why this one. The justification standard signals that a decision is consequential, and it is how design knowledge accumulates.

Colour decisions are, almost universally, exempted from this standard. The question why this colour? is seldom asked in design critique, and when it is asked, answers such as "it felt right," "it suits the brand," or "it works with the other elements" are commonly accepted as sufficient, in a way the equivalent answers would not be accepted for a structural or material decision. This exemption is so normalised that it is rarely experienced as a problem. But it is the clearest expression of colour's misclassification: a domain treated, in practice, as falling below the threshold of serious accountability.

Here the framework and the capacity meet, and this is the central argument of the paper. Accountability for colour decisions is not possible without the framework, because one cannot justify a colour decision without knowing which domains of colour knowledge it draws upon, and by which ways of knowing. To answer why this colour? responsibly is to answer with reference to the relevant domains: to the cultural and strategic context that informed the decision (Area 01), to the perceptual and inclusive requirements of the people it serves (Area 02), to the material and technical constraints that shaped it (Area 03), and to the environmental and temporal conditions under which it will perform (Area 04). The four domains are, in this sense, the very structure of a colour justification. They are what a well-reasoned answer to why this colour? is made of. Without the map of the territory, accountability has no content; it can only gesture at intuition. With it, accountability becomes a concrete practice: the designer locates the decision within the relevant domains, marshals the knowledge each requires in the way of knowing appropriate to it, and justifies the choice accordingly. The other four capacities support this: recognition identifies the decision as a colour decision in the first place; integration gathers the knowledge across domains; temporality ensures the decision is made early enough to be shaped by that knowledge rather than retrofitted to it; and ethics orients the whole toward the people who will live with the result.

This argument has a specific and timely implication for AI-assisted design. Generative image systems will not accept an intuitive colour decision; they require it to be verbalised before it can be executed. A designer working with a generative tool must specify the hue, the saturation, the finish, the relationship between tones, in language, before the system can act. The tool imposes, by technical necessity, precisely the accountability design culture has never required voluntarily: the demand that a colour decision be put into words. The verbalisation demand of the generative tool and the justification demand of the framework are, at bottom, the same demand. The designer who cannot say why this colour cannot direct the tool, just as they cannot defend the decision in critique. Design's long tolerance of colour intuition, sustained because intuition was never required to explain itself, is being ended not by pedagogy but by the operating conditions of the discipline's newest tools.

4. The framework in practice: colour decisions across the domains

The framework's value is clearest when a single colour decision is traced across the domains it touches. In practice, consequential colour decisions rarely belong to one domain alone; they move through several, and accountability requires the designer to answer for the decision in each. Five worked examples follow, drawn from different fields of design practice, each reading a colour decision as a movement across the framework.

A global brand colour for a new market. Consider a designer adapting a global brand's colour identity for a culturally distinct market, the situation behind the beverage-industry noted earlier. The decision begins in Area 01: it requires cultural research into what the proposed colours communicate in the specific market, historical understanding of local associations, and strategic reasoning about the relationship between colour and brand equity. This is where the beverage company failed, deploying a light blue associated regionally with mourning without the cultural research the domain demands. But the decision does not stay in Area 01. It moves into Area 02, where the designer must consider how the colours will be perceived by the actual population, including those with colour vision deficiency, and whether the palette carries inclusive or exclusionary associations for the communities it addresses. It moves into Area 03, where the brand colours are composed into a colour plan and specified to production standards, held within tolerance across every manufactured touchpoint. And it resolves in Area 04, where the colours are evaluated in situ on real signage under real light and on real screens, and tracked over time. A designer accountable for this decision must answer for it in all four domains; a failure in any one — unresearched culture, excluded users, unmatched production, unevaluated performance — is a failure of the whole.

A hospital wayfinding system. A colour-coded wayfinding scheme for a hospital begins, unusually, in Area 02, because its governing consideration is human: the perceptual and cognitive experience of navigating a stressful environment, including the substantial minority of users with colour vision deficiency and the age-related changes in colour perception common among patients. Competence here yields the principle of redundant coding, pairing each colour with a distinct pattern so that no user depends on colour alone. But the decision also draws on Area 01, in understanding the cultural colour associations of the medical sector across its usage; on Area 03, where the colours are composed into a colour plan and specified so they reproduce consistently across painted surfaces, printed signs, and digital displays, and hold under the building's actual lighting; and on Area 04, where the system is evaluated once installed, to confirm it reduces disorientation and continues to perform as signage ages. The wayfinding decision that fails is almost always one made in a single domain; an aesthetically pleasing palette selected without the Area 02 knowledge that renders it navigable.

A bio-based colour for a product. A designer choosing a bacterial or algae-derived colourant for a textile or product, following bio-pigment projects such as Living Colour (Luchtman & Siebenhaar, 2017), makes a decision anchored in Area 03: the material and biological behaviour of the colourant, its fastness, its production process, its place within the emerging science of living colour. But the decision is legible as a colour decision only across the full framework. It draws on Area 01 in its strategic and ethical framing, the state of the art of ecological responsibility made visible through colour; on Area 02 in ensuring the palette remains perceptually effective and inclusive; and, crucially, on Area 04, where the colour's defining characteristic — that it may shift and fade over time as a living material — must be anticipated and later evaluated not as a failure of stability but as an intended quality of colour evolution. That intention is recorded in the colour plan when the colourant is chosen (Area 03); whether the evolution is in fact experienced and valued as intended is what Area 04 assesses. A designer who specifies a bio-colour with only the material knowledge of Area 03, and who has formed no Area 04 account of how its temporal change will be received, has made an incomplete decision.

A data-visualisation colour system. A designer building the colour scheme for a dashboard, an information graphic, or a data-heavy interface, makes a decision that is easy to mistake for pure aesthetics and is in fact one of the most constrained colour problems in design. It is anchored in Area 02, because its first obligation is perceptual and inclusive: a categorical palette must remain distinguishable for the substantial minority of users with colour vision deficiency, which rules out the red-green pairings still common in financial and medical charting, and a sequential or diverging scale must preserve a perceptually uniform progression so that equal steps in the data read as equal steps in colour, a property that naive rainbow scales notoriously violate. The decision then draws on Area 03, where the chosen colours must survive the quantitative realities of digital reproduction — the gamut limits of different screens, the shifts introduced by varying calibration, and the need for sufficient measured contrast against background and between adjacent categories — and where the colour plan, the documented set of categorical hues, scale endpoints, and contrast ratios, becomes the specification handed to developers. It extends into Area 04, where the palette must be evaluated across the actual devices and lighting conditions in which the data will be read, from a calibrated desktop monitor

to a phone in sunlight. Area 01 is present too, more quietly, in the conventions a given field attaches to colour, the expectation that red marks loss or danger, green gain or safety, which the designer must either honour or deliberately subvert. A data-visualisation palette chosen for visual appeal alone, without the Area 02 knowledge that governs its legibility, is among the most common and most consequential colour failures in contemporary practice, because it silently excludes readers and distorts the data it was meant to clarify.

An architectural colour scheme for a public building. A designer or architect developing the colour scheme for a building, a façade in an urban streetscape, or the interior of a civic or healthcare space, makes a colour decision that unfolds across all four domains over a timescale measured in years. It begins in Area 01, with the cultural and contextual intelligence the setting demands: the local colour identity of the place, the heritage and material palette of its surroundings, the regional and historical colour conventions a new intervention will either continue or disrupt. It moves deeply into Area 02, because a building is inhabited: the colours must support wellbeing and orientation for the people who will use the space, account for how colour is perceived under the specific daylight and artificial lighting of the site across seasons, and serve diverse and sometimes vulnerable populations, patients, children, older adults, whose perceptual and psychological responses to colour differ. It is realised through Area 03, where architectural colour meets the hard constraints of materials: the coatings, renders, cladding, and finishes available; their fade resistance, weathering, and maintenance behaviour; and the CMF decisions that determine how a specified colour will actually appear on a given surface at architectural scale; it is here that the scheme is composed into an architectural colour plan. And it is tested and sustained in Area 04, the domain where architectural colour is most exposed, because a building's colour performs in public, under changing light, through weather and ageing, for decades: the scheme must be evaluated for how it reads at different distances and times of day, how it will weather and patina, how it integrates with and affects its surrounding environment, and how it can be maintained or renewed. Architectural colour is perhaps the clearest demonstration that a colour decision is not a moment but a trajectory, and that accountability for it requires reasoning across the full territory the framework maps.

In each case the framework performs the same work. It converts a diffuse sense that "colour matters here" into a specific account of which domains of knowledge the decision engages, which ways of knowing each requires, where in the design process each is called upon, and how the resulting decision can be justified. This is what it means to make colour accountable: not to eliminate judgement, but to give it structure, evidence, and a language in which it can be defended.

5. Implications for design education and practice

The framework asks of design not a reorganisation of the curriculum but a reorientation of attention. Its central claim for education is that colour decisions are already present throughout the work designers do and teach, in material specification, in brand strategy, in wayfinding, in data visualisation, in healthcare communication, in AI-assisted production, and that these decisions can be taught as the colour decisions they are, wherever in the curriculum and the process they appear.

The foundational colour course is not the problem, and this paper does not propose abolishing it. Perceptual training in colour relationality is valuable and should be retained. The problem is the assumption that it is sufficient, that colour, having been addressed in the first year, has been dealt with. When the foundational course is followed by no colour content in materials or production courses, no colour criteria in project briefs, no colour accountability in design critique, and no colour research in professional practice, the discipline signals that foundational colour is all a designer requires. The framework challenges that signal, and offers educators a map of where colour knowledge can be integrated into existing courses without creating new ones. Colour management and quality control, which already live in production and prepress teaching, can be framed explicitly as colour competence, the quantitative core of Area 03. Colour, accessibility, and wellbeing belong in briefs for environmental and communication design (Area 02). Cultural and narrative colour research belongs in any brief addressing diverse audiences, global markets, or visual storytelling (Area 01). The colour plan, lifecycle, and evaluation belong within delivery and sustainability teaching (Area 04). What the framework adds, in each case, is the recognition that these are colour decisions, subject to colour accountability, drawing on distinct but equally valid ways of knowing.

For practitioners, the framework functions as an instrument of self-assessment. The question it prompts is which domains of colour knowledge do I navigate with confidence, and in which do I default to intuition because I have never been equipped with the evidence? A materials specialist who commands the knowledge of Area 03 but has never engaged the qualitative cultural research of Area 01 can now name the gap precisely. A brand strategist strong in Area 01 but unschooled in the perceptual research of Area 02 can locate what is missing. The framework does not demand expertise across all four domains; it demands awareness of all four, and the capacity, precisely the capacity of integration, to recognise when a decision requires knowledge one does not yet hold, and to seek it. And it fosters practising colour accountability across the full framework,

holding together the quantitative and qualitative ways of knowing that colour literacy, fully understood, requires.

6. Conclusions

Colour is an infrastructure of consequential decision-making, distributed across the full arc of design practice, that the discipline has not yet claimed with the seriousness those decisions require. This paper has argued that the remedy is not more colour content in a single course, but a map of the territory colour occupies, and it has offered one: a framework for colour competence in design, developed across seventeen years of research and teaching, evolved from a literature-grounded description of the phases of colour decision-making into an author-derived account of the domains of colour knowledge, and aligned with the design process through the Double Diamond model.

The framework's four domains, Colour Context and Strategic Framing; Colour, Human Experience and Inclusion; Colour Decision and Materialisation; and Colour Performance and Impact, describe not a sequence but a landscape: four stable territories of colour knowledge, each with its own characteristic ways of knowing, that any practitioner making serious colour decisions must navigate. Operating across them are the five capacities of colour literacy, recognition, integration, accountability, temporality, and ethics, foremost among them, at this moment, accountability. The paper has argued that accountability is the competence the framework makes operable, because a colour decision can be justified only by reference to the domains of knowledge it draws upon and the ways of knowing they require. The four domains are the structure of a colour justification; they are what a reasoned answer to the question why this colour? is made of.

The contemporary challenges that intersect with colour, sustainability, inclusion, algorithmic mediation, cultural responsibility, are intensifying, not receding, and each brings new demands the framework expects to absorb as the emphasis among its capacities shifts. The design discipline will continue to be present at the colour decisions these challenges demand. Whether it is present with the knowledge and the accountability those decisions deserve is the question the framework sets out to answer. Colour literacy is not a specialist credential, nor competence in a single way of knowing; it is a basic condition of responsible design practice, and it requires the capacity to move between the many ways colour is known. The work of building it is overdue, and it is entirely possible.

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