The Realizability of Authorial Interior Design in the United States: The Role of CGI, Technical Detailing, and Coordination with General Contractors

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Abstract

Authorial interior design in the United States often loses fidelity between the studio concept and the finished space, and this study examines why that loss occurs and how it can be reduced. The aim is to characterize the realizability gap and to analyze how computer-generated imagery (CGI), technical detailing, and coordination with general contractors operate together to close it. The work combines a structured review of peer-reviewed sources, comparative analysis of market and labor data, and a single case study of a cross-border studio that serves United States clients with a European design language and a remote production team. Results show that the visualization market grows faster than design services, that construction rework and a verified labor shortage raise the cost of misaligned documentation, and that treating CGI as the binding reference rather than a sales asset lowers rework risk. The conclusion confirms the aim by presenting an alignment proposal and practical recommendations. These findings are useful for interior designers, CGI studios, general contractors, real-estate developers, and workforce-policy stakeholders.

Keywords: interior design; computer-generated imagery; architectural visualization; technical documentation; general contractor coordination; building information modeling; construction rework; cross-border service delivery; design intent; realizability.

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Introduction

Interior design in the United States is a sizable and growing service market, yet the route from a designer's concept to a built room remains uneven. Grand View Research estimated the United States interior design market at about 55.035 billion United States dollars (USD) in 2025, with a projection toward 85.31 billion USD by 2033 at a compound annual growth rate near 5.7 percent [1]. Demand for visualization is expanding on a steeper curve: the global three-dimensional (3D) rendering market was valued near 4.85 billion USD in 2025 and is projected to reach 19.82 billion USD by 2033, a compound annual growth rate close to 19.6 percent [2], with architectural visualization accounting for roughly 42 percent of 2025 rendering revenue and North America holding about 43 percent of that revenue [3]. The two curves describe a single tension. Clients can now see a photoreal result before construction, and they expect the built space to match it.

At the same time, the United States construction sector is short of the craft labor that turns a detailed design into a finished interior. The 2025 workforce survey by the Associated General Contractors of America and the National Center for Construction Education and Research reported that 92 percent of firms had difficulty filling open positions, that worker shortages were the first-named cause of project delays, and that the average construction wage had reached 39.69 USD per hour [4]. The Home Builders Institute placed the annual economic cost of the skilled-labor shortage in home building near 10.8 billion USD, partly through longer construction times [5]. When a design carries fine tolerances and uncommon details, a thin and overstretched trade base raises the chance that the built result will drift from the drawing.

Visualization research helps explain why the gap matters and where it can be closed. Tural and Tural [6] showed, through eye-tracking and virtual reality (VR) evaluations of photoreal interior scenes, that immersive presentation changes how people read materiality and spaciousness, which means a CGI image is not a neutral record but an instrument that sets client expectations. Gomez-Tone and colleagues [7] found that immersive VR sharpens spatial understanding during early design, and Kim and Hyun [8] reported that design review in VR surfaces issues that flat media miss.

Osorto Carrasco and Chen [9] measured gains in design comprehension when mixed reality was added to the review, and Israr and colleagues [10] demonstrated a markerless augmented reality (AR) tool that lets stakeholders place and check 3D elements in a real room. Adoption studies in the architecture, engineering, and construction sector confirm that these tools have moved from novelty to routine use [11, 12]. The construction-side literature reinforces the point from the other direction: Teo and colleagues [13] showed that building information modeling (BIM) coordination of mechanical, electrical, and plumbing systems prevents on-site clashes, and Mostofi and colleagues [14] reported that the cost of rework can reach a meaningful share of contract value when documentation and coordination are weak.

The research gap sits between these two literatures. Visualization studies treat CGI mainly as a perception or marketing instrument, and construction-management studies treat coordination mainly as a clash-detection and rework problem. Few sources connect the two as one accountability chain in which the same photoreal target governs documentation and field verification, and fewer still examine how a cross-border studio, with a European design language and a remote production team, delivers that chain into the United States market. **The aim of this study** is to characterize the realizability gap between authorial interior design intent and built outcomes in the United States, and to analyze how CGI, technical detailing, and coordination with general contractors operate together to close that gap, using a single cross-border delivery case as evidence.

The scientific novelty of the work is its framing of CGI not as a sales artifact but as the binding reference that links design intent, technical documentation, and on-site coordination within one verifiable chain of accountability. **The authorial hypothesis** is that design intent is realized more reliably when the photoreal visualization is treated as the shared reference for documentation and field checks rather than as a separate marketing deliverable, and that cross-border teams pairing a European design language with United States-standard documentation can deliver this alignment at competitive cost and schedule.

The study carries limitations that the reader should hold in view, although none undercut its main claims. It rests on a single delivery case whose financial and operational figures are reported by the studio and not independently audited, so the case illustrates a model rather than proving its generality. Several market figures come from commercial research providers whose estimates vary in scope and method, and the analysis is qualitative and United States-focused, so the proposed alignment may need adjustment for other regulatory settings.

The work is meant to be useful in a practical and a public sense. Studios, general contractors, and developers gain a structured way to reduce rework and to protect design intent, which matters in a market where labor is scarce and schedules are tight [4, 5]. There is also a connection between this kind of skilled cross-border practice and the wider United States built environment: visualization and documentation talent that lowers rework and shortens delivery helps housing and commercial fit-out keep pace despite a thin trade base, and it brings detailing standards and design methods into United States projects through reliable collaboration with local contractors. Linking that talent to dependable execution is one modest contribution to construction productivity and to the quality of the spaces the country builds.

Materials and Methods

The study uses a mixed and mainly qualitative design built on four methods. The first is a structured review of peer-reviewed literature on visualization, design communication, and construction coordination, restricted to sources published and selected for direct relevance to interior or architectural practice. The second is a comparative analysis of market and labor indicators, which places visualization-demand growth next to interior-design market growth and the United States construction-labor picture, so that the realizability gap can be read against measurable trends. The third is a single case study of a cross-border studio that serves United States clients, used to ground the abstract chain in concrete metrics on price, schedule, and contract volume. The fourth is a content analysis of the technical-documentation and coordination practices described in the construction-management sources, which informs the mapping of failure points to documentation mechanisms.

The source base is deliberately small and is classified by type. The first group is peer-reviewed academic articles and conference papers on visualization, perception, and BIM coordination, which carry the theoretical weight of the argument. The second group is market and labor data from recognized research providers and industry bodies, used only for current quantitative context. A third input, kept separate from the literature, is the case studio's internal record for 2023 to 2025, which the studio supplied and which is treated as reported case data rather than as verified fact.

The theoretical part of the analysis draws on the perception and visualization sources and on the coordination sources. The market and practical parts draw on the data group and on the case record. Selection followed three rules: recency within the 2019 to 2026 window, traceability to a stable identifier such as a digital object identifier or an official report, and direct bearing on the realizability question. Blogs, press releases, and unverified pages were excluded. The result is a base of fourteen cited sources, weighted toward peer-reviewed work, with data sources held to current quantitative use.

Results and Discussion

Demand for what the client sees is growing faster than demand for the design service itself, while the capacity to build fine detail is constrained. The contrast is the point, because it shows that the photoreal image is becoming the common language of the transaction even where the underlying service grows modestly. The rendering market's higher growth rate signals that clients increasingly decide on the basis of a photoreal target, which raises the stakes of any mismatch between the image and the build. The visualization spend is concentrated in North America [3], so United States projects are precisely where the image-to-build expectation is sharpest. When this expectation meets a constrained trade base [4, 5], the risk of visible drift between design and result rises rather than falls. The combined signals are summarized in the table below, which gathers the quantitative anchors of the argument in one place so that the qualitative discussion can refer back to them.

Table 1. Market and labor indicators framing the realizability gap (compiled by the author based on [1-5]).

Indicator	Value	Year
United States interior design market size	55.035 billion USD	2025
United States interior design market forecast	85.31 billion USD; CAGR ~5.7%	2033
Global 3D rendering market size	4.85 billion USD	2025
Global 3D rendering market forecast	19.82 billion USD; CAGR ~19.6%	2033

Architectural visualization share of 3D rendering revenue	~42%	2025
North America share of 3D rendering revenue	~43%	2025
Construction firms reporting difficulty filling open positions	92%	2025
Average United States construction wage	39.69 USD per hour	2025
Estimated annual economic cost of skilled-labor shortage in home building	~10.8 billion USD	2025

Design intent is not lost at one point but leaks across a sequence of handoffs, and each handoff is a place where the photoreal target and the built result can separate. The construction-management evidence is direct on this: clash and coordination failures concentrate at the transition from design documentation to field installation, where systems meet in real space [13], and rework cost rises when that transition is handled late or with incomplete information [14]. The next diagram presents the pipeline the author uses to organize the discussion. It is drawn as a linear sequence with a verification loop, because the central claim is that the loop, not the sequence, determines fidelity.

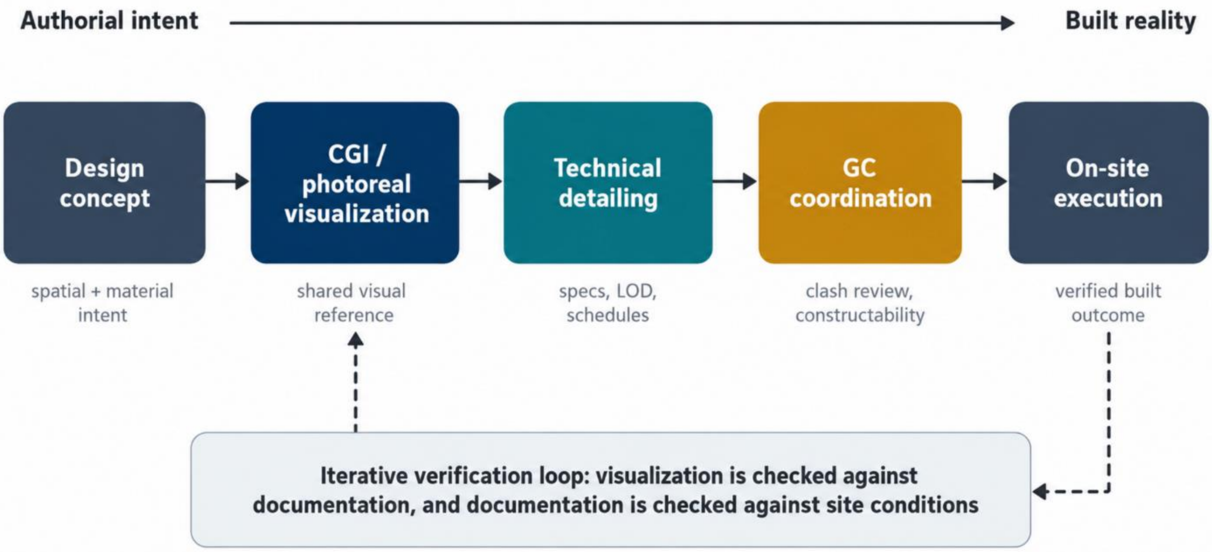

Figure 1. Design-to-build realization pipeline with an iterative verification loop (compiled by the author based on [9, 13, 14]).

In a routine workflow the visualization is produced for client approval and then set aside, while documentation and site work proceed on their own track. The pipeline shows why this is fragile. Once the CGI stops governing the later stages, the only references left are the drawings and the contractor's reading of them, and the evidence shows that this reading is where errors cluster [13]. The author's reframing is to keep the approved CGI active as a reference at the detailing and coordination stages, so that documentation is checked against the image and field work is checked against both.

To make the loss points actionable, the following table maps common realization risks to the documentation or coordination mechanism that addresses each, with the supporting evidence named. The table is an authorial synthesis: the risk points are drawn from the construction-management sources, and the mechanisms are organized to align with the pipeline rather than copied from any single reference.

Table 2. Realization risk points mapped to documentation and coordination mechanisms (compiled by the author based on [9, 13, 14]).

Risk point	Typical cause	Mechanism that addresses it
Image and drawing diverge	CGI set aside after approval	Keep approved CGI as the binding reference through detailing
Implied tolerances	Fine details shown but not specified	State tolerances and level of detail in schedules
Late system clashes	Coordination begins after layouts fix	Run BIM clash review before installation
Rework on site	Field decisions under schedule pressure	Resolve conflicts in the model, not in the field
Lost accountability	No reference linking sign-offs	Chain sign-offs back to the same visual target

The economics of the loop are worth stating, because they explain why the loop pays for itself. Estimates of rework cost vary with how rework is defined and measured, and Mostofi and colleagues [14] report figures that range from a low single-digit share of contract value to a far higher share once change orders and quality failures are included. The reason for that spread matters here. Rework concentrates at the documentation-to-field transition, so a control that keeps documentation aligned with the approved image acts on the part of the curve where cost accumulates. Set this against the labor picture in Table 1: when the average construction wage sits near 39.69 USD per hour and crews are scarce enough to be the first-named cause of delay [8], every avoidable correction consumes hours that the schedule cannot spare. The loop in Figure 1 is therefore not a quality nicety. It is a way to protect the scarcest input in the system, which is skilled field time, by moving the decision from the site back into the model where it costs less to make and to change.

It also reframes a common assumption. Visualization is often booked as a marketing line item, which implies that its value ends at the client's approval. The pipeline shows the opposite. The same photoreal asset that won the approval is the reference that can govern the build, and discarding it after approval throws away the control just as the project enters the stage where control is needed. Treating the image as a standing reference rather than a closed deliverable is a change in posture more than a change in cost, and it is the hinge on which the rest of the analysis turns.

The third result grounds the model in a working practice. The case studio carries more than fifteen years of design experience and about four years of direct work in the United States market. It pairs a European design language with a remote production team whose workstations are configured to United States standards, and it leads the United States-facing relationship while the team executes the detailing. The studio reports an average project duration of two to ten weeks depending on scope, against a domestic comparison it places at roughly twice that span, and a starting price near 5 USD per square foot, against a common United States range it places at or above 10 USD per square foot for output it judges less detailed. The studio also reports recognition in the International Property Awards program, a juried regional industry scheme, including a CGI category award for the United States and Florida in 2024 and a private-residence interior award in 2025. These figures are reported case data, not audited results, and they are used here to illustrate the model rather than to rank the studio.

The clearest signal in the case record is the trajectory of contract revenue, which the next chart presents. The point is not the absolute figures, which are modest, but the slope, which is consistent with a delivery model that clients return to and refer onward.

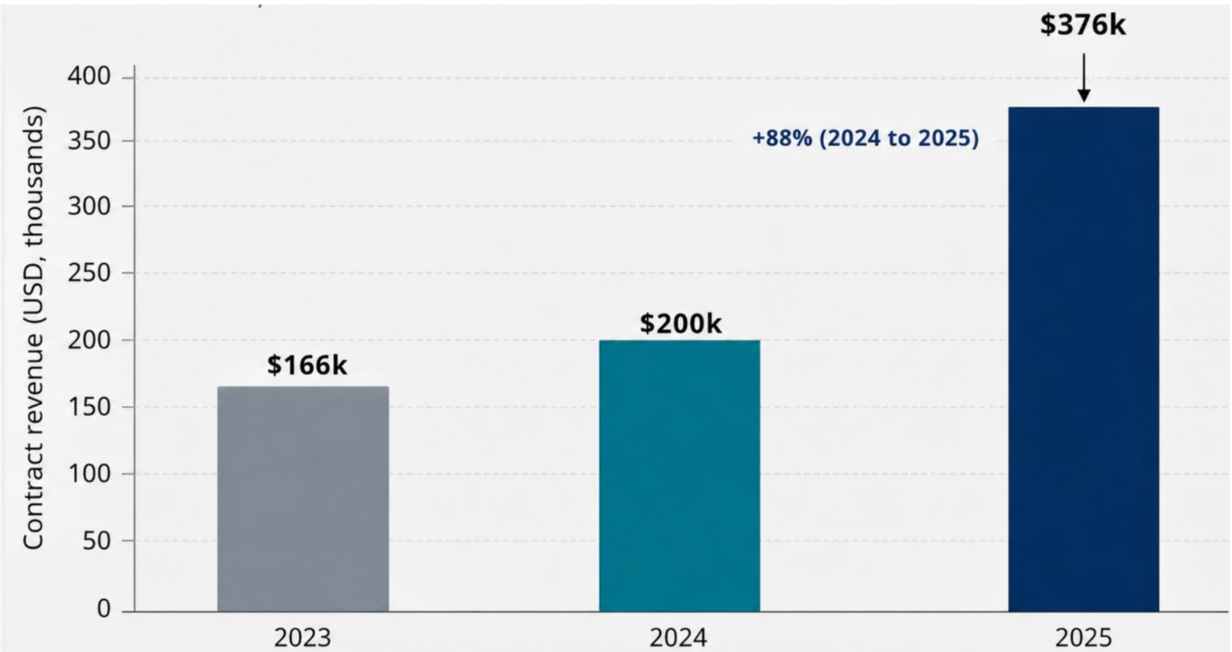

Figure 2. Case studio contract revenue, 2023 to 2025 (compiled by the author based on case studio internal records, 2025).

Revenue moved from 166,000 USD in 2023 to 200,000 USD in 2024 and to 376,000 USD in 2025, an increase near 88 percent in the final year, alongside more than twenty contracts reported for 2025. Read against Table 1, the pattern is coherent. The studio sells into the part of the market where the photoreal target carries the decision [3], it competes on a price point below the range it cites for comparable United States output, and it compresses schedules in a market where labor scarcity stretches timelines [4, 5]. The table below sets the case positioning next to a typical local provider so that the trade-offs are explicit.

Table 3. Case studio positioning relative to a typical United States local provider (compiled by the author based on case studio internal records, 2025, and [1, 4]).

Dimension	Case studio (reported)	Typical U.S. local provider (reported comparison)
Starting price per square foot	from about 5 USD	from about 10 USD
Project duration	2 to 10 weeks by scope	about twice as long
Delivery model	U.S.-facing lead, remote detailing team	in-house local team
Design language	European, photoreal CGI	varies
Market context	premium and renovation demand	premium and renovation demand
Labor exposure	lower (remote production)	higher (local craft base)

The fourth result is the author's constructive proposal. If the verification loop in Figure 2 is the mechanism that protects intent, then a practice needs a clear way to keep three things aligned: the design language and its CGI, the United States-standard documentation, and the contractor-side coordination. The next diagram presents the alignment model the author proposes, organized as three layers that all reference one approved visual target. The model is a way of working rather than a piece of software, and it is meant to be read together with Tables 2 and 3.

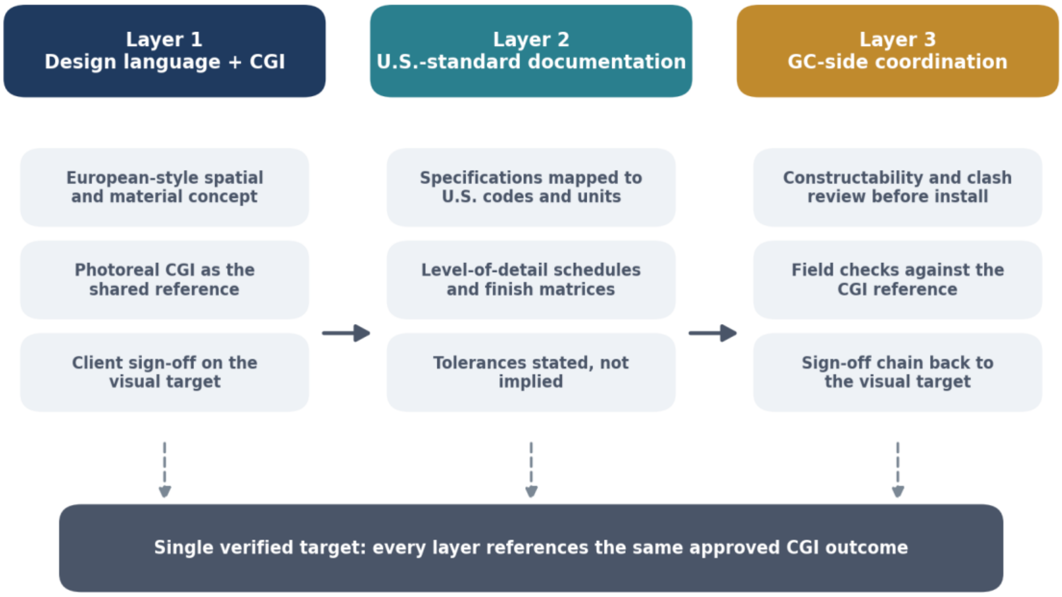

Figure 3. Visualization-documentation-coordination alignment model for cross-border delivery (compiled by the author based on [9, 10, 13]).

Layer one fixes the design intent and turns it into a photoreal reference that the client approves, which matters because immersive and photoreal presentation measurably shapes how clients read a space [6, 7, 9]. Layer two translates that reference into documentation that a United States contractor can build from, with specifications mapped to local codes and units, level-of-detail schedules, and stated rather than implied tolerances, which is exactly the discipline that the coordination literature associates with fewer clashes [13]. Layer three returns the work to the field, where constructability review, clash resolution, and checks against the CGI keep the install on target, and where AR tools can place the model in the real room for a direct comparison [10]. The single anchor at the base, the approved visual target, is what gives the model its accountability: every sign-off points back to the same image, so drift becomes visible rather than silent. This is the operational form of the study's hypothesis.

The model also explains the case result without special pleading. A cross-border team can hold layer one and layer two to a consistent standard because both are produced inside the studio, and it can connect to layer three by selecting general contractors able to read detailed documentation and to coordinate against a CGI reference. The studio's own framing, that local builders cannot always realize its more demanding designs, is better understood not as a judgment about skill but as a coordination problem: where the contractor never receives the image as a binding reference, the chain in Figure 3 is broken at layer three, and intent leaks regardless of the contractor's competence.

From the analysis the author draws five recommendations for studios and their construction partners. First, treat the approved CGI as a contract reference, named in the scope and revisited at detailing and coordination, so that it governs the build rather than the sale. Second, write tolerances and levels of detail into schedules wherever the visualization shows a feature that a drawing would otherwise leave implied, since implied detail is where the build and the image separate [13]. Third, run model-based clash review before installation as a standing step rather than an exception, which the coordination evidence ties to lower rework [13, 14]. Fourth, select general contractors on their ability to coordinate against a visual reference, and give them AR or model access so the comparison happens in the room, not on paper [10]. Fifth, for cross-border practices, keep design and documentation inside one standard and invest the saved schedule time in the field-verification loop, which is where the case studio's speed advantage can be protected rather than spent. None of these steps requires new technology; each redirect existing tools toward a single verified target.

A practice can tell whether the model is working by watching a few measurable signals rather than relying on impressions. The count of requests for information and field change orders should fall as documentation is tied to the image, because fewer questions arise when tolerances are stated and the reference is shared [13]. The share of the schedule spent on correction should shrink, which is the schedule time that the case studio converts into its speed advantage. Repeat and referral rates should hold or rise, which is the pattern visible in the case revenue slope in Figure 2. None of these signals requires new instrumentation; each is already tracked on many projects, and reading them against the alignment model turns the model from an argument into something a studio can manage by.

There is a wider implication worth stating plainly. The visualization market is growing into the role of the common reference for design decisions [2, 3], and the United States trade base is too stretched to absorb avoidable rework [4, 5]. A practice that keeps the image, the documentation, and the field on the same target reduces that waste, and it does so with people and tools that already exist. That is a small but real contribution to how well the country builds the interiors it pays for.

Conclusion

This study set out to characterize the realizability gap between authorial interior design intent and built outcomes in the United States, and to analyze how CGI, technical detailing, and coordination with general contractors work together to close it. The aim is met. The market and labor analysis showed that the photoreal image is becoming the common reference of the transaction while the trade base that must realize it is constrained, which is the structural source of the gap. The pipeline and the risk mapping located the loss at the handoff from documentation to field work and named the mechanisms. The case evidence showed that a cross-border model pairing a European design language with United States-standard documentation can deliver competitive price and schedule, with a revenue trajectory consistent with repeat and referred work.

The contribution is the framing that runs through these results: CGI delivers its value when it is the binding reference that links intent, documentation, and coordination in one accountable chain, rather than a marketing asset that is approved and then set aside. The alignment model in Figure 3 turns that framing into a way of working, and the five recommendations turn it into practice. The practical significance is concrete. Studios protect intent and reputation, contractors reduce rework, developers gain predictable outcomes, and the wider construction system loses less of the scarce labor it has to avoidable correction. The findings will interest interior designers, CGI and visualization studios, general contractors, real-estate developers, and stakeholders concerned with construction productivity and workforce policy. Future work can test the alignment model across more cases and regulatory settings and can measure its effect on rework directly.

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