The Architect as Digital Craftsman

Revisiting manual dexterity through artificial intelligence

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This study investigates how artificial intelligence (AI) can complement, rather than replace, manual dexterity in architectural design. Drawing on data from 158 pavilion projects, it develops a hybrid design model in which architects mediate between machine logic and human craftsmanship. Through the DeepSmart Corpus Research, a comprehensive design ontology is constructed, revealing how AI enhances the improvisational, tactile, and material-aware qualities of traditional building practices. The dataset includes over 5,000 data points across 32 design features, offering a nuanced understanding of human–machine collaboration. The findings contribute to a growing discourse on human–machine collaboration in architecture, proposing a future where digital tools amplify, rather than diminish, the role of the human hand. The study emphasizes the need for integration where AI serves as an enabler of craftsmanship, enhancing rather than eclipsing the human designer's tactile and conceptual contributions.

Keywords: *Digital craftsmanship, Artificial intelligence in architecture, Architectural Data, Pavilions, Semantic and syntactic analysis.*

INTRODUCTION

The rise of digital tools has radically reshaped the practice of architecture and led to a critical reassessment of the role of the architect in technology-driven processes. Today's architects are increasingly viewed as "digital craftsmen," integrating parametric design, generative algorithms, and robotic fabrication into their workflows. However, the emergence of artificial intelligence (AI) introduces a new shift one that does not seek to replace human-centered manual skills but instead revives and repositions them. AI's capacity to optimize, predict, and automate design and construction workflows offers an opportunity to reengage with tactile, intuitive, and improvisational skills that once defined medieval craftsmanship. Through the DeepSmart Corpus Research, this study analyzes a dataset of 158 pavilion projects, each examined through 32 architectural features, resulting in 5,056 qualitative, quantitative, and contextual data entries. These pavilions, seen as laboratories for architectural experimentation, serve as the basis for constructing a design ontology that maps the evolving relationship between traditional handcraft and digital innovation. The research reveals that AI, and computational tools can enhance the material sensitivity and spatial imagination traditionally associated with manual craft. Rather than opposing technology and tradition, the study introduces a hybrid model in which humans and machines interpret architectural data both semantically and syntactically, suggesting a return to foundational

design values. In this model, future architects much like their medieval counterparts are envisioned as makers who balance technical mastery with creative intuition, shaping a built environment that is both technologically advanced and deeply human.

To investigate this hybrid model, the study examines three interrelated dimensions: the semantic and syntactic interpretation of design by AI, the significance of manual dexterity in creative processes, and the pavilion as a site of convergence for these elements. It explores how AI tools can complement rather than replace manual craftsmanship in the design and construction of architectural pavilion.

Exploring semantic and syntactic dialogues with the machine

The Artificial Intelligence (AI) refers to the development of systems that replicate human cognitive abilities such as learning, problem-solving, and decision-making (Turing, 1950). Fallowing Turing's foundational work and the 1956 Dartmouth Conference (McCarthy et al., 1956), AI has evolved from symbolic reasoning systems like the Logic Theorist to more recent advances in machine learning (ML). ML models whether supervised, unsupervised, or reinforcement-based allow machines to learn patterns through repetition and feedback (Sutton & Barto, 1998), whereas neural networks mimic brain-like structures to enhance capabilities in image recognition and speech processing (LeCun et al., 2015). Natural Language Processing (NLP), a branch of AI, interprets both syntactic structure and semantic meaning, supporting tasks such as sentiment analysis and text classification by simulating human language comprehension (Manning & Schütze, 1999). These developments are not merely technical milestones but represent a broader dialogue between AI and human cognitive systems both of which engage in meaning-making through pattern recognition, symbol manipulation, and contextual awareness.

In the context of architecture, AI serves as more than a tool for automation; it acts as a creative collaborator. Described as "data is the new oil," data fuels AI's capacity to generate insights from structured and unstructured sources (Steenson, 2017). Rather than replacing the architect's intuition, AI augments it, offering new ways to navigate form, material, and context. As Chaillou (2022) emphasizes, AI empowers architects to iterate, simulate, and test design logic semantically and syntactically, without undermining human agency. This co-intelligence model foregrounds the integration of machine learning into design workflows while preserving the tactile and interpretive dimensions of architectural creativity.

Dexterity in the age of digital tools

As digital tools and automation increasingly influence architectural design and construction, the role of manual dexterity remains pivotal. While computational design and robotic fabrication offer precision and efficiency, they do not supplant the need for human intuition, sensory engagement, and real-time adaptability. Instead, manual dexterity complements technological workflows, embodying a form of intelligence that adeptly responds to uncertainty and material feedback. Richard Sennett emphasizes that craftsmanship represents the special human condition of being engaged, highlighting the intrinsic value of hands-on involvement in the creative process.

Contemporary pavilion design exemplifies the synergy between digital and manual practices. Architects now operate within hybrid workflows, integrating computational design with traditional craftsmanship to produce innovative and adaptive structures. This collaborative approach aligns with Donna Haraway's concept of symbiosis 'making-with' which underscores the interconnectedness of humans, machines, and materials in the creative process. By embracing this multi-dexterous paradigm, the human hand

remains central to architectural innovation, effectively translating abstract computational ideas into tangible, meaningful forms.

Pavilions

This chapter introduces the methodological framework developed for analyzing pavilion architecture within the scope of the DeepSmart Corpus. The research focuses on a curated dataset of 158 pavilions, classified into three primary typologies: Serpentine Pavilions, Research Pavilions, and World Exposition Pavilions. These typologies provide a basis for critically examining the design evolution of pavilions as experimental spaces. The chapter is structured to include a review of pavilion typology and its architectural relevance, an explanation of the 32 thematic classification headings, and an overview of the DeepSmart Corpus project's structure and research goals.

The 32 thematic headings presented in Figure 1 establish the core analytical framework of this research. They facilitate a multi-scalar assessment of pavilion projects by structuring data across three distinct levels: quantitative, qualitative, and interpretive. This three-tiered approach integrates objective measurements with subjective design interpretations. Additionally, Figure 1 provides a visual complement to this analytical framework through an exploded diagram, clearly depicting the spatial and structural elements of pavilion architecture. By merging measurable attributes with descriptive and conceptual insights, this methodology enables comparative evaluations and the identification of patterns across a diverse range of pavilion designs.

To ensure clarity and consistency in data interpretation, quantitative values such as area, volume, part count, and labor input are formatted in bold, providing key numerical insights into design and construction. Qualitative attributes, including architect, site conditions, shape, and materials, are presented in regular font and emphasize contextual and descriptive aspects of each pavilion. Interpretive data, shown in italics, capture cultural, conceptual, and thematic narratives derived from designers' statements and project documentation. This layered approach facilitates a holistic understanding of pavilion architecture, bridging empirical evidence with critical reflection.

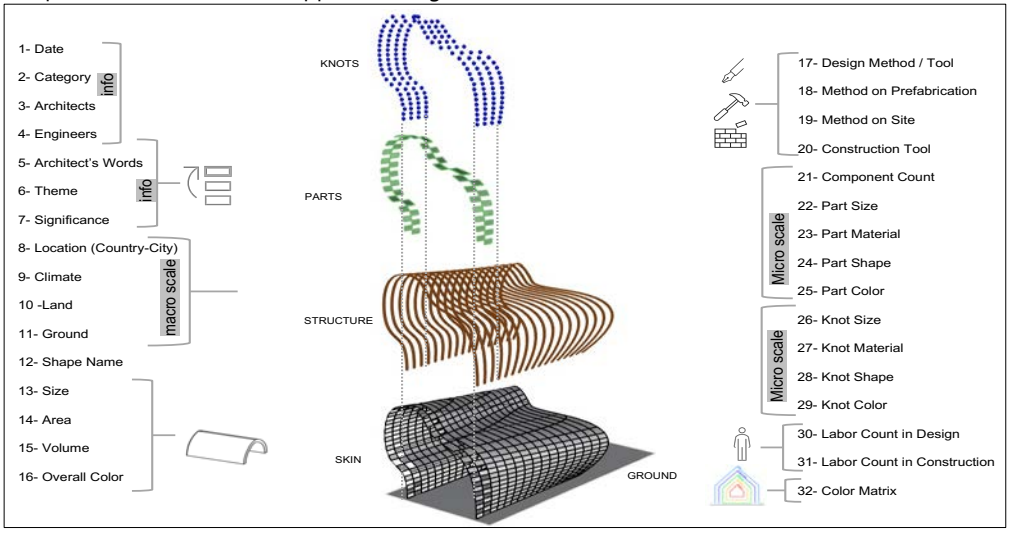


Figure 1
Exploded diagram of typical pavilion components, developed by the author (2025).

At the core of pavilion design, the architect plays a pivotal role in generating and developing design concepts that balance aesthetic aspirations with practical requirements. The "architect's word category" encompasses the conceptual framework within which architects operate, reflecting the underlying principles, design strategies, and creative visions that inform architectural practice. This category emphasizes the architect's role in synthesizing artistic and functional considerations to produce innovative, contextually responsive architectural solutions.

The thematic analysis of pavilion design was structured into ten key subheadings, reflecting a range of computational and traditional strategies. These include algorithmic, parametric, and biomimetic approaches, as well as data-driven and AI-supported methods. Additional categories address immersive visualization tools (e.g., VR/AR), responsive design using sensors, and performance-based optimization techniques. While many of these emphasize adaptability and sustainability, the inclusion of traditional craftsmanship ensures a balanced dialogue between innovation and experience in architectural workflows.

Complementing this, the significance of each pavilion was assessed across ten evaluative subheadings, such as design and structural innovation, material experimentation, and sustainability performance. Technological integration, educational value, and cost-effectiveness were also considered, alongside scalability, aesthetic expression, and handcrafted detail. Together, these criteria offer a holistic lens through which to understand how pavilion architecture operates as a testing ground for emerging ideas, tools, and values.

Together, these criteria offer a comprehensive framework for understanding the significance and impact of pavilion architecture.

OVERVIEW OF THE DEEPSMART CORPUS RESEARCH PROJECT

The DeepSmart Corpus investigates pavilion architecture as a testbed for innovation in design, materiality, and fabrication. It analyzes 158 pavilions constructed between 2000 and 2024, drawn from three main typologies: Serpentine Pavilions, Research Pavilions, and World Exposition Pavilions. These case studies are categorized under 32 thematic headings, resulting in a robust dataset of 5,056 entries encompassing qualitative, quantitative, and contextual data. This comprehensive dataset forms the basis for constructing a design ontology that captures the dynamic interplay between traditional handcraft and emerging digital techniques.

The ontology developed through this research addresses key architectural dimensions such as material experimentation, geometric configuration, spatial strategy, and construction method. The analysis places particular emphasis on the adaptability and temporality inherent to pavilion architecture, identifying how design strategies evolve in response to changing environmental, cultural, and technological conditions. This layered understanding provides insights into how new forms of architectural knowledge emerge through the integration of digital tools and manual expertise, ultimately contributing to the broader discourse on architectural intelligence.

The DeepSmart framework mirrors both human cognition and machine learning logic by examining pavilions across multiple scales ranging from fine material details to overall spatial organization. It uses structured data analysis to detect recurring patterns, enabling the identification of correlations between design tools, material types, and construction approaches. In doing so, the research highlights the relevance of data-informed processes as a means to guide future design strategies and

innovations in architectural practice, especially in experimental and research-based contexts.

Historically, pavilions have operated as pedagogical instruments structures through which material and technological experimentation occurs at full scale. The DeepSmart Corpus builds on this tradition by creating a digital repository of pavilion design intelligence. It addresses the limitations of digital representation, which often struggles to fully capture the complexity of physical materialization at full scale. By linking design theory with fabrication logic, the project offers a more grounded and actionable model for bridging the conceptual and the constructed in contemporary architecture.

The integration of machine learning into the DeepSmart framework enables predictive modeling of future design tendencies. Algorithms trained on the curated pavilion dataset can identify relationships between material choices, digital tools, and construction methods. This supports a hybrid design intelligence, where human intuition and computational precision converge. Ultimately, the research promotes a future vision in which architects operate as data-driven craftsmen balancing creative judgment with technological innovation to shape adaptive, resilient, and meaningful architectural environments.

DATA-DRIVEN DESIGN EVALUATION

This research adopts a two-phase analytical framework to examine pavilion architecture through both manual and computational means. In the first phase, a comprehensive dataset was manually compiled in Excel by the author, focusing on critical attributes such as design method, construction method, geometric shape, materials, and construction tools. The dataset includes 158 pavilion projects, and no synthetic or artificially generated data was used. When specific information could not be verified or found, the corresponding fields were marked as N/A, ensuring data transparency and integrity.

In the second phase, an AI-assisted model was implemented to evaluate predictive patterns based on the curated dataset. The machine learning classifier was trained on real, author-collected data, allowing for grounded insights into how different combinations of construction methods, design tools, and material choices influence architectural outcomes. This approach not only highlights emerging design and construction trends but also illustrates how AI can be leveraged to support human intuition and craft in architectural research.

Phase one: manual compilation and curation of the dataset

Between 2000 and 2024, 71 out of 158 pavilion projects were designed using computational tools, reflecting a significant shift toward parametric modeling, algorithmic workflows, and digitally supported design processes as illustrated at Figure 2. These methods have empowered architects to address complex geometries, optimize material performance, and achieve higher precision, especially in experimental and research-driven contexts.

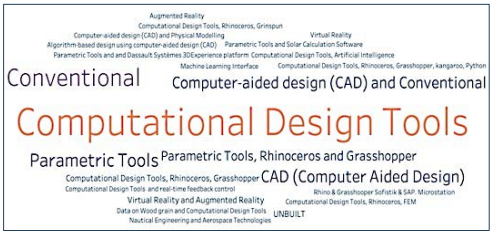
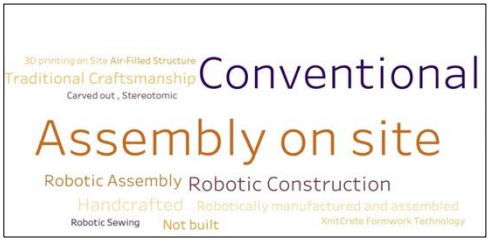


Figure 2
Design Tools, developed by the author (2025).

Computational design offers flexibility, customization, and early-stage performance simulation, while its integration with digital fabrication technologies enables a seamless transition from concept to construction and supports interdisciplinary collaboration. Despite this trend, 26 pavilions still employed conventional design methods, underscoring the continued value of manual craftsmanship and

intuitive decision-making. The coexistence of both digital and traditional approaches highlights a diverse and evolving design culture in pavilion architecture, where innovation and hands-on processes collectively enrich spatial and material outcomes.

Out of 158 analyzed pavilions, 69 were constructed using field-assembly methods, underscoring their increasing relevance in contemporary architectural practice as illustrated at Figure 3. This approach offers notable advantages such as faster construction timelines, reduced material waste, enhanced quality control, and minimal site disruption particularly beneficial for temporary or experimental structures in urban or environmentally sensitive contexts.



By shifting most fabrication off-site, field-assembly not only improves safety but also enables greater design experimentation with advanced materials and complex geometries that would be challenging to execute through traditional on-site methods. The modularity and precision of prefabricated components enhance logistics and allow for rapid installation, adaptability, and reuse. When combined with digital design and fabrication tools, field-assembly and prefabrication together form a sustainable, efficient, and flexible strategy for pavilion construction, supporting innovation while addressing evolving spatial and environmental demands.

Among the 158 pavilion projects analyzed, 106 were constructed using conventional tools, reflecting the sustained reliance on traditional construction practices in the field as seen at Figure 4. While advancements in robotic and automated fabrication have emerged, their adoption remains limited and sporadic. Some projects have explored robotic or pneumatic systems, showcasing potential for innovation in material handling and precision, yet these examples are relatively rare. Handcrafted methods continue to be widely used, emphasizing material authenticity, localized

Figure 4
Construction Tools, developed by the author (2025).

Figure 3
Construction Method, developed by the author (2025).

knowledge, and the value of manual labor. This enduring preference highlights an appreciation for the tactile and expressive qualities that traditional tools bring to architectural experimentation.

Overall, the coexistence of conventional and emerging tools indicates a transitional phase in construction methods, where digital technologies gradually integrate into workflows without fully replacing established techniques. This hybrid environment allows for flexible design strategies that draw from both craftsmanship and technological innovation.

Phase two Ai-assisted model

In Phase Two, an AI-assisted model was utilized to generate predictive insights from the curated pavilion dataset, with a specific focus on the variable "Construction Method on Site." Two separate classification models were developed: one targeting handcrafted pavilions to predict likely materials and geometries, and another focusing on robotically constructed pavilions to

forecast trends in material use, design logic, and fabrication strategies.

These models aim to reveal how different construction methods influence design outcomes and to project future patterns in pavilion architecture. A Decision Tree Classifier was developed using 32 architectural features, focusing on the variable "Construction Method on Site." A commonly used training-validation data split was applied to ensure balanced learning and testing conditions. The model demonstrated strong performance across standard evaluation metrics, including accuracy, precision, and F1-score, while maintaining interpretability through pruning techniques that reduced overfitting. This process reflects a hybrid approach, combining human-curated data with AI-guided reasoning to uncover meaningful patterns in pavilion design.

Prediction of construction patterns based on handcrafted pavilions

This section analyzes the future trajectory of handcrafted pavilion construction using a curated dataset of projects built between 2000 and 2024. The relationship between manual labor and factors such as material selection, tool type, geometric forms, and design approaches was examined. A Decision Tree Classifier was then implemented to identify recurring patterns and predict likely construction strategies for the next years.

The results highlight consistent correlations between construction methods and material usage. Manually assembled pavilions with conventional tools tend to adopt wood and steel, often forming hexagonal prisms, panels, or modular shapes. Structures involving rope-based geometries, particularly spherical or tensile forms, typically use steel-rope composites, leveraging the tactile adaptability of hand-based techniques. Interestingly, projects that integrate manual labor with digital preparation such as parametric modeling have begun incorporating emerging materials like bioplastics, especially in organically shaped, 3D-printed components. These outcomes demonstrate that handcrafted workflows, while rooted in tradition, are expanding through hybrid design logic.

As shown in Table 1, traditional materials like wood, rope, and steel remain central in manual construction, especially when paired with repetitive or modular geometries. However, the growing influence of digital design tools is evident in the emergence of more fluid, expressive forms and biodegradable materials. In these hybrid examples, manual labor persists not only as a construction method but as a form of adaptive intelligence that negotiates material constraints and site-specific conditions.

Looking forward, handcrafted pavilions are expected to follow two complementary trajectories. One path will preserve traditional methods, emphasizing physical precision, tactile feedback, and cultural authenticity particularly through joinery and in-situ craftsmanship. The other will embrace digitally prepared manual assemblies, enabling novel geometries and sustainable material systems that respond to environmental concerns. In both cases, the craftsman's role evolves from solely building to mediating between digital tools and hands-on problem-solving.

Ultimately, the predictions suggest that manual dexterity will remain vital within architectural experimentation, not as an outdated practice, but as a dynamic, evolving intelligence. The intersection of human skill and computational design offers a fertile ground for architectural innovation where craft and code,

Table 1
Prediction of Handmade Constructed Pavilions, developed by the author (2025).

Tool Type	Geometry	Material	Craft Skills
Conventional	Hex Prism	Wood	Joinery, modular
Parametric	Organic Cylinder	Bioplastic	Precision shaping
Conventional	Rope Form	Steel and Rope	Tensile Adaptation

memory and machine, can shape a more nuanced and resilient built environment.

Prediction of construction patterns in robotically constructed pavilions

This section examines how robotic construction has shaped pavilion architecture between 2010 and 2024, focusing on material choices, geometric forms, and fabrication strategies. Drawing from a curated dataset of projects involving on-site robotic assembly, the analysis highlights how digital tools and machine-based construction have converged to redefine design and execution processes in pavilion design as seen at Table 2.

Tool Type	Geometry	Material	Craft Skills
Robotic Arm	Non-standard, Freeform	Carbon Fiber Composite	Calibration, Assembly Alignment
CNC Milling Machine	Modular Panels	Plywood/ MDF	Surface Finishing, Manual Fitting
3D Printing	Organic Surfaces	Bioplastics / Polymer	Support Removal, Post-Processing
Robotic Filament Winding	Tensile, Woven Structures	Glass / Carbon Fiber	Precision Setup, layer Control
Robotic Hot Wire Cutting	Complex Folded Forms	Foam Blocks /EPS	Toolpath adjustments, Error Correction

Table 2
Prediction of Robotically Constructed Pavilions, developed by the author (2025).

Early robotic pavilions often used wood in modular formats slats, panels, and strips adapting traditional materials for automated workflows. However, from 2012 onward, carbon fiber composites became more prominent, supporting complex, curvilinear geometries and reflecting a shift toward performance-driven, lightweight materials. This evolution underscores how robotic precision enables experimentation with materials that are both structurally efficient and environmentally responsive.

Robotic construction favors non-standard geometries realized through modular logic. Forms like "strips" and "panels" are guided by parametric design platforms such as Rhinoceros and Grinspun algorithms. These tools coordinate precise robotic fabrication, minimizing waste and ensuring fidelity between digital models and physical outcomes, while opening new creative possibilities.

Looking forward, three trends are anticipated: the adoption of responsive, bio-based materials; the rise of multi-layered, adaptive structures; and the development of context-aware robotic fabrication with real-time feedback. These will support mass-customized, sustainable pavilion designs that blend efficiency with expressive form.

In summary, robotic construction is expanding the architectural tectonics of pavilions, combining computational control with material innovation. As this approach matures, hybrid workflows that merge robotic precision with human creativity will define a new era of digital craftsmanship in architecture.

Comparative evaluation of robotic vs. handmade construction methods

The comparative analysis of handcrafted and robotically constructed pavilions reveals clear distinctions in material selection, geometric complexity, and tool usage as seen at Table 3. Drawing from a decision tree classifier trained on pavilion data spanning two decades, the study confirms that the construction method manual versus robotic is the most influential factor in predicting material outcomes. This initial split in the decision model underlines how the mode of making fundamentally shapes architectural expression and fabrication logic.

Manual construction is closely associated with traditional materials such as wood, steel, and rope, typically combined with simple, repetitive geometries like panels or prisms. These pavilions often rely on conventional tools and on-site craftsmanship, were tactile feedback and adaptive skill guide material assembly. In contrast, robotic construction is linked to advanced materials such as carbon fiber and custom composites, especially when used in slat- or strip-based geometries enabled by computational design. The data

supports this dichotomy: when robotic methods are paired with digital tools and modular forms, carbon fiber consistently emerges as the preferred material.

The accompanying table synthesizes these patterns, showing that handcrafted pavilions prioritize conventional materials and forms that support manual joinery, while robotic pavilions explore complex forms through digitally controlled processes. The decision tree also reveals hybrid conditions for instance, manual construction with computational design tools tends to result in wood-based assemblies shaped through CNC cutting, suggesting the increasing presence of digitally informed craftsmanship.

Looking ahead, both approaches will continue to shape pavilion design. Manual techniques will remain essential where contextual adaptation, cultural narrative, and material reusability are prioritized. Meanwhile, robotic systems will expand their reach through the integration of smart materials, sensor technologies, and real-time feedback systems, supporting expressive and performance-driven forms.

Table 3
Comparison Handmade and Robotically Constructed Pavilions, developed by the author (2025).

Feature	Manual Construction	Robotic Construction
Common Materials	Wood, Steel, Rope	Carbon Fiber, Wood, Bioplastics
Construction Tools	Conventional Tools (hand tools)	Robotic Arm, Automated Fabrication
Design Method	Conventional or CAD	Computational / Parametric
Shape	Simple forms, repetitive units	Complex, non-standard geometries
Labor	High Manual Labor	Low manual labor, higher automation
Shape Features	Panels, Prisms, Ropes	Slats, Strips, Organic Surfaces

Ultimately, this evaluation underscores the need for hybrid workflows that combine the precision of machines with the intuition of hands. Rather than opposing paradigms, robotic and manual craftsmanship are complementary forces together advancing innovation, sustainability, and material intelligence in pavilion architecture.

CONCLUSION

Dexterity the adaptive intelligence of the human hand continues to play a vital role in the evolving landscape of architectural design, particularly within the context of pavilion construction. As robotic fabrication and artificial intelligence increasingly shape architectural workflows, this study emphasizes that manual craftsmanship remains essential, not as a relic of the past, but as a living, evolving form of design intelligence. Through a comparative analysis of handcrafted and robotically constructed pavilions, the research demonstrates that manual skills enable a nuanced understanding of materials, spatial organization, and improvisational design strategies that machines alone cannot replicate.

Handcrafted pavilions tend to employ traditional materials such as wood, rope, and steel, combined with modular and repetitive geometries that reflect the maker's intuitive engagement with the physical environment. These projects highlight the architect's role as both designer and fabricator, where context, hands-on adaptation, and experiential knowledge inform the final outcome. In contrast, robotic construction introduces a different form of dexterity one rooted in algorithmic precision, repeatability, and geometric ambition. When paired with computational design tools, robotic systems enable the use of advanced materials like carbon fiber and composites, pushing the boundaries of what is materially and formally achievable.

The classification model developed in this study confirms that construction method is the most decisive predictor of material selection and

geometric form. This insight affirms that both human and machine intelligence are integral to design, each offering distinct advantages. Rather than framing manual and robotic approaches as oppositional, the findings support a hybrid model, where digital preparation meets hands-on assembly, and AI acts as an augmentative partner to craftsmanship. Such workflows not only preserve the cultural and tactile richness of architecture but also enable scalable, adaptable solutions for future challenges.

In this light, manual dexterity emerges as an indispensable element of architectural knowledge capable of embedding care, memory, and local specificity into the built environment. The hand does not disappear in the age of automation; it evolves in dialogue with machines. This study contributes to architectural theory by offering a framework for hybrid workflows where AI supports material and design decisions grounded in embodied making and traditional craft.

Looking ahead, future research could build on these findings by incorporating generative AI models and reinforcement learning to further enhance iterative, co-creative design processes. Tools such as GANs or large multimodal language-vision models could propose novel design typologies, while reinforcement learning could drive real-time adaptation based on structural, environmental, or user feedback. These advancements promise to expand the possibilities of digital craftsmanship, making architecture not only more intelligent and efficient but also more expressive, human-centered, and responsive.

REFERENCES

Anumba, C. J., et al. (2021). Cyber-physical systems in construction. *Automation in Construction,* 123, pp.103-482.

Artificial intelligence and architectural design: An overview. n.d. *Research & Development in Digital Methodologies*. Available at: https://upcommons.upc.edu/bitstream/handle/2117/406674/9788419184498-01.pdf [Accessed 10 March 2025].

Augmented computational design: Methodical application of artificial intelligence in generative design. (2023). Available at: https://arxiv.org/abs/2310.09243 [Accessed 10 March 2025].

Chaillou, S. (2022). *Architecting with AI: From Design Automation to Co-Creation.* Routledge.

DeepCraft: Co-Intelligent Architecture and Human and AI-Driven Processes. (n.d.). *In Advances in Computational Design and Digital Fabrication*. Springer. Available at: https://link.springer.com/chapter/10.1007/978-981-99-8405-3_31 [Accessed 10 March 2025].

Generative AI for architectural design: A literature review. (2024). Available at: https://arxiv.org/abs/2404.01335 [Accessed 10 March 2025].

LeCun, Y., Bengio, Y., & Hinton, G. (2015). Deep learning. *Nature,* 521(7553), pp.436–444.

Manning, C. D., & Schütze, H. (1999). *Foundations of statistical natural language processing.* Cambridge, MIT Press.

McCarthy, J., Minsky, M. L., Rochester, N., & Shannon, C. E. (1956). A proposal for the Dartmouth summer research project on artificial intelligence.

Shengli, Z. (2021). Digital twins in architecture and engineering. *Journal of Intelligent Construction*, 8(2), pp.45–52.

Steenson, M. W. (2017). *Architectural Intelligence: How Designers and Architects Created the Digital Landscape.* Cambridge, MIT Press.

Sutton, R. S., & Barto, A. G. (1998). *Reinforcement learning: An introduction.* Cambridge, MIT Press.

Turing, A. M. (1950). Computing machinery and intelligence. *Mind,* 59, pp.433–460.

SUPPLEMENTARY MATERIALS

The DeepSmart Corpus Dataset is available at: https://aycayaz.com/phd/