

Embedding AI into Architectural Workflows: Design Process Reengineered

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Abstract:

This study examines the use of Artificial Intelligence (AI) in a fourth-semester architecture studio focused on personalized dwellings within urban settlements. Animated characters were used to represent diverse user profiles, helping students understand individual and community needs. Immersive tools, including virtual reality, enabled deeper engagement with user-centric principles, fostering empathy, creativity, and adaptability. The approach signals a pedagogical shift toward identity-driven, interactive, and technology-enhanced design methods. AI tools streamlined workflows, improved client engagement, and supported adaptive solutions. Socially, the method promotes inclusivity by acknowledging varied identities, reducing alienation in built environments. The novelty lies in merging animated proxies with AI and VR, creating an innovative experiential learning framework that enhances empathy and introduces fresh approaches in architectural education and practice.

Keywords: Artificial Intelligence (AI), Architectural Design, Immersive Technologies, Interactive Design Process

INTRODUCTION OF AI: Artificial intelligence (AI) is technology that enables computers and machines to simulate human learning, comprehension, problem solving, decision making, creativity and autonomy. Applications and devices equipped with AI can see and identify objects. They can understand and respond to human language. They can learn from new information and experience. They can make detailed recommendations to users and experts. They can act independently, replacing the need for human intelligence or intervention (a classic example being a self-driving car).

But in 2024, most AI researchers, practitioners and most AI-related headlines are focused on breakthroughs in generative AI (gen AI), a technology that can create original text, images, video and other content. To fully understand generative AI, it's important to first understand the technologies on which generative AI tools are built: machine learning (ML) and deep learning. (Cole Stryker, 2024)

Artificial Intelligence in Architecture: Artificial Intelligence (AI) is significantly transforming the architecture field by enhancing design efficiency, accuracy, and creativity through data-driven processes and intelligent algorithms. AI-Powered tools enable architects to automate repetitive tasks such as drafting, space planning, and environmental analysis, allowing more time for conceptual development and innovation. Generative design platforms, like Autodesk's Dreamcatcher or space maker AI, use machine learning to explore countless design iterations based on user-defined parameters, optimizing for factors such as sunlight, ventilation, and spatial organization (Autodesk, 2020). Furthermore, AI facilitates predictive analysis in urban planning and sustainable design, helping architects make informed decisions about energy efficiency and material usage early in the design phase. As AI continues to evolve, it is reshaping the architect's role from a traditional designer to a strategic thinker and data informed problem solver (Burry).

The architectural design process has traditionally revolved around abstract spatial problem-solving with a focus on functionality, aesthetics, and context. However, with the advent of Artificial Intelligence (AI) and immersive technologies, architects now have access to powerful tools that allow for more user-centred, data-informed, and creative design approaches. This paper investigates a novel pedagogical model where AI and animated characters are used to guide fourth-semester architecture students through the process of designing personalized dwellings. The approach emphasizes experiential learning and empathy, preparing students for the evolving needs of 21st-century urban settlement design.

Methodology Integrating Artificial Intelligence: The Studio Process

This studio adopted an experiential, design-based research methodology grounded in constructivist pedagogy. The learning framework was structured into nine iterative phases, merging character-driven narrative exploration with artificial intelligence (AI) and immersive virtual technologies. The aim was to cultivate personalized housing solutions—both individual and collective—that responded deeply to user identity, context, and performance.

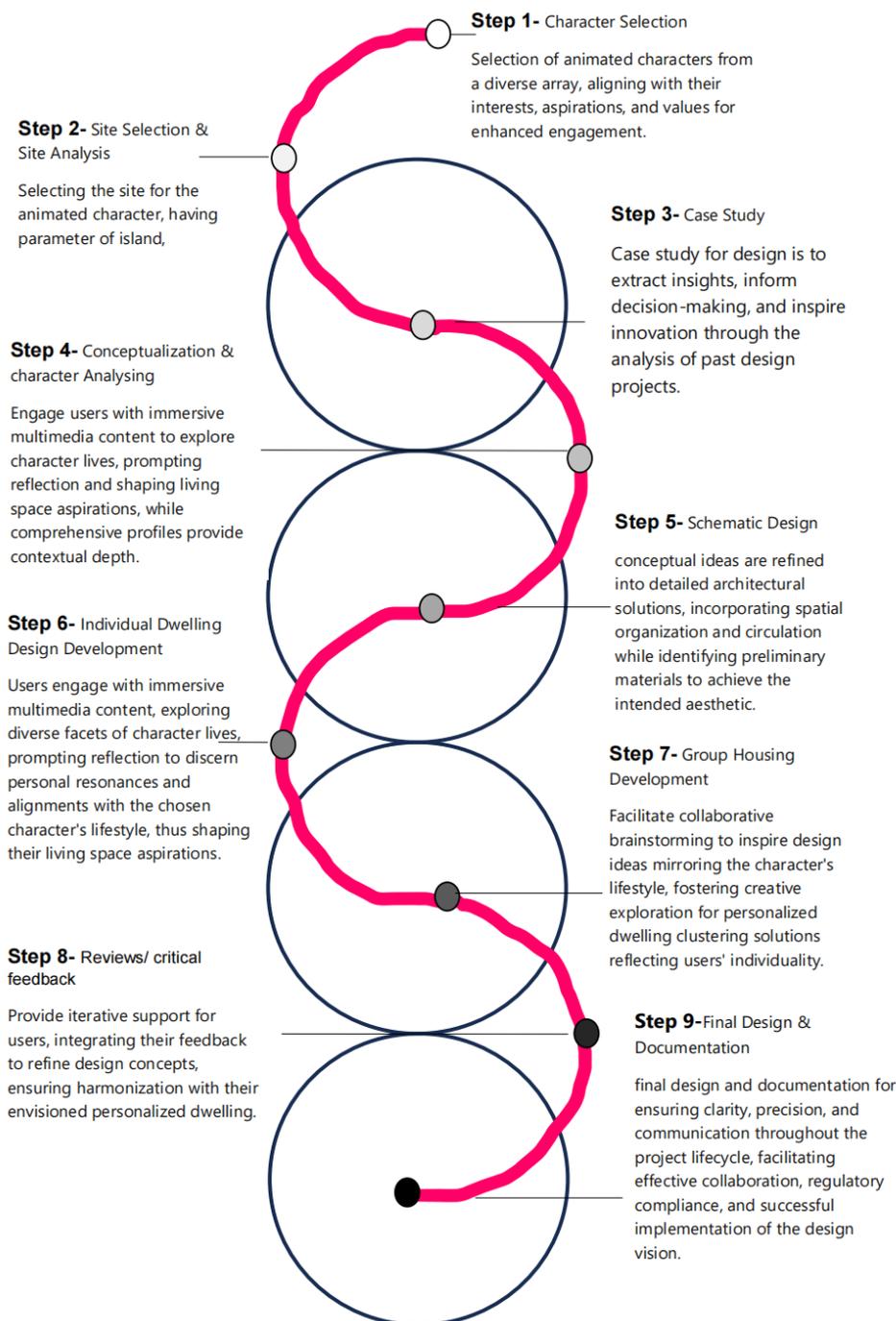


Figure 1 The Studio Process

Step 1: Character Selection

The process began with each student selecting an animated character whose values, aspirations, and lifestyle choices resonated with their own interests. These characters served as rich proxies for user personas, helping students explore psychological, emotional, and cultural dimensions of space. The act

of character selection set the foundation for empathy-driven design, encouraging students to understand spatial requirements from a personal, human-centred perspective.

Step 2: Site Selection and Site Analysis

Building on the character's narrative, students selected Sant Mary Island (Thonsepar). It is a set of four small islands in the Arabian Sea, off the coast of Malpe in Udupi, Karnataka, India. Comprehensive site analyses were undertaken, including topographic mapping, climate responsiveness, environmental sustainability, accessibility, and regional cultural cues, etc. These findings informed early massing strategies and spatial orientation, grounding the character's story within a realistic ecological and social context.

Step 3: Case Study

Students investigated architectural precedents focusing on personalized housing and innovative community living models. Through diagrams, spatial mapping, and critical reviews, they examined elements such as zoning, orientation, circulation flow, materiality, user interaction, and adaptability. Key takeaways were systematically abstracted and adapted to support the schematic development of their own projects.

Step 4: Conceptualization and Character Analysis

Students engaged deeply with the fictional lives of their characters using detailed biographies, fan-generated content, behavioural archetypes, and media representations. This analysis informed spatial needs, routines, aspirations, and symbolic interpretations of space. The process served as a bridge between imagination and pragmatism, leading to the formulation of conceptual diagrams, narrative maps, and thematic design frameworks.

Step 5: Schematic Design

Early spatial ideas were translated into schematic plans, focusing on zoning, volumetric massing, movement, and interaction. AI-enabled platforms facilitated rapid prototyping and spatial iteration. Tools such as Forma and Space Maker allowed students to evaluate options quickly, test scenarios, and visualize spatial relationships in real-time, enabling more informed and responsive design decisions.

Step 6: Individual Dwelling Design Development

Students advanced their designs through performance-based iterations supported by AI and virtual reality (VR) tools. This included daylight simulations, energy use analytics, and immersive walk-throughs using platforms like Enscape and Lumion. The aim was to refine spatial quality and functionality while maintaining fidelity to the character's identity. The resulting dwellings reflected nuanced lifestyle alignments, with tailored interiors, adaptive layouts, and context-aware material palettes.

Step 7: Group Housing Development

Collaborative teams formed character-based micro-communities where compatible lifestyles intersected. Using AI-assisted urban planning tools, students developed clusters with shared amenities, open spaces, and walkable networks. The focus was on designing inclusive, socially cohesive environments that reflected the collective ethos of the character groups, while addressing density, privacy gradients, and sustainable infrastructure.

Step 8: Reviews and Critical Feedback

Multiple review cycles were held, incorporating critiques from faculty, peers, and AI-aided diagnostic tools. Students received feedback on spatial articulation, user experience, constructability, and narrative coherence. Additionally, AI-generated environmental performance reports (including daylight access, wind flow, and energy efficiency) were used to validate and enhance design robustness.

Step 9: Final Design and Documentation

The final phase required students to synthesize their process into comprehensive design portfolios. Deliverables included architectural drawings, rendered perspectives, data-integrated diagrams, virtual models, and interactive presentations. Emphasis was placed on visual clarity, analytical rigor, and narrative depth. AI tools ensured technical accuracy while immersive technologies helped convey spatial atmospheres aligned with the character-driven design narrative.

Ex 1: Concept Inspired by Natural form or element (Prompt: /imagine Prompt abstract sketch of a building form, inspired by Eagle bird, located near sea shore, facade of the building has wide opening and allows the cross ventilation)



Figure 2 Image generated with AI: (AI Tool: mid journey)

Ex 2: Prompt: Harry Potter house located on st. marry island near Malpe beach, house is designed glass & steel, having back yard for quidditch pitch.

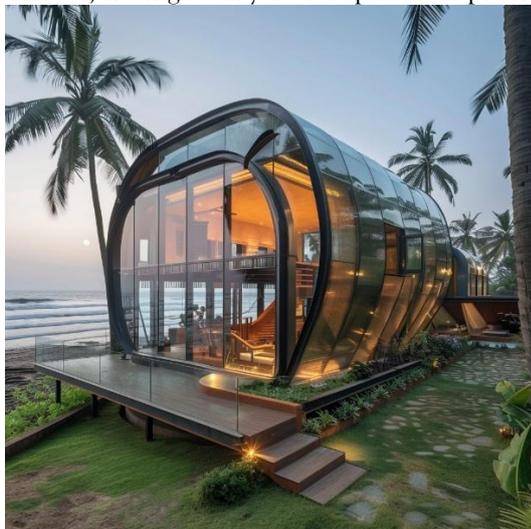


Figure 3 Image generated with AI: AI Tool: (mid journey)

Integration of Artificial Intelligence: Integration of Artificial Intelligence in the Design Process Artificial Intelligence significantly transformed multiple facets of the design process by automating complex tasks, generating responsive design solutions, and enriching the experiential quality of outputs. Compared to traditional methods that rely heavily on manual drafting, linear design thinking, and iterative trial-and-error, AI-enabled design facilitates rapid prototyping, predictive modelling, and performance-based feedback.

- **Data Analysis:** AI algorithms were employed to interpret and analyse user behaviour patterns derived from character narratives. These patterns helped define spatial needs, zoning strategies, and lifestyle-driven layouts. Traditionally, such data would be extrapolated manually from surveys or demographic studies.
- **Generative Design:** Advanced platforms like Space maker and Autodesk Forma enabled students to generate a wide range of spatial configurations based on given parameters such as user needs, climate responsiveness, and site constraints. These tools provided optimized layout suggestions in a fraction of the time needed using conventional sketch models or physical iterations.
- **Visualization:** Real-time rendering engines enhanced with AI capabilities, including Lumion AI and Enscape, allowed students to create photorealistic environments and walkthroughs. In traditional workflows, rendering required extensive manual settings and long processing times, whereas AI-driven visualization offers instant feedback and higher realism, improving decision-making.

- **Feedback Simulation:** AI provided performance-based evaluations related to energy efficiency, thermal comfort, daylighting, and spatial utilization. Unlike traditional static assessments or post-construction evaluations, AI-driven simulations introduced dynamic, scenario-based testing that allowed real-time iteration and refinement.
- **Enhancement of Design Quality:** AI enhanced design quality by streamlining repetitive tasks, offering data-backed insights, and expanding creative possibilities. Students could explore a broader design space, validate decisions with quantitative feedback, and create highly customized, user-aligned environments. This led to better environmental integration, improved user satisfaction, and more innovative architectural expressions.
- By integrating AI into the architectural studio, the pedagogical approach moved beyond representational design into performance-oriented and behaviour-responsive architecture. The synergy between technology and creativity facilitated a richer understanding of user needs, enabled precision in execution, and fostered innovation through computational exploration.

Outcomes and Reflections

The integration of animated characters and Artificial Intelligence (AI) technologies within the studio project yielded a multidimensional transformation in both design outcomes and student learning experiences. The methodology stimulated cognitive, emotional, and technical growth among the students, as outlined below:

- **Greater Student Empathy and Self-Awareness:**

By embodying animated characters with unique aspirations, fears, and routines, students were encouraged to emotionally engage with user personas in a way that traditional design briefs often lack. This engagement nurtured empathy, as students were required to consider the psychological well-being, cultural background, and day-to-day needs of their characters. The immersive experience also prompted students to reflect on their own values and preferences, creating a mirror effect that heightened self-awareness and introspective design decisions.

- **Stronger Narratives Embedded in Spatial Design:**

The narrative-driven process enabled students to construct spatial environments that were not only functional but also deeply personal and meaningful. Each design was rooted in a backstory, personality traits, and imagined lifestyle of the character. This storytelling dimension strengthened the conceptual foundation of the projects and gave rise to emotionally resonant architectural expressions—ranging from the arrangement of private vs. social zones to symbolic material choices reflecting the character's identity.

- **Improved Understanding of User-Centric Design:**

Through repeated reflection on the character's behaviour patterns, routines, and needs, students internalized core principles of user-centric design. This went beyond spatial ergonomics to include sensory experiences, privacy needs, emotional comfort, and adaptive flexibility. The process helped students transition from designing "spaces" to designing "experiences," tailored to specific users rather than generic profiles.

- **Enhanced Creativity Through Interdisciplinary Thinking:**

The fusion of character analysis (typically seen in psychology, animation, or literature) with architectural planning led to unconventional and imaginative solutions. Students blended design with storytelling, behavior science, and technology, thereby broadening their creative horizons. This interdisciplinary approach encouraged risk-taking, curiosity, and speculative exploration—qualities vital to innovation in contemporary architecture.

- **Faster Iteration Cycles and Feedback Loops Using AI:**

The application of AI tools drastically enhanced workflow efficiency. Platforms such as Space maker and Forma generated multiple viable design options quickly, enabling students to test and refine concepts without starting from scratch. Visualization tools like Enscape and Lumion AI accelerated the process of rendering immersive experiences, which made reviews more interactive and meaningful. Real-time simulations and feedback mechanisms allowed for continuous learning and adjustment, mirroring the iterative nature of professional design processes.

Students reported a heightened sense of engagement throughout the studio, with many describing the process as "more real" and "emotionally immersive" compared to conventional design projects. Designing

for a 'lived' personality challenged them to confront assumptions about domestic life, routine behaviours, and even cultural expectations. Many noted that AI tools reduced their workload on time-consuming tasks such as environmental analysis, schematic modelling, and visualization. This freed up cognitive resources for ideation, critical thinking, and refinement of spatial narratives.

The studio outcomes, therefore, did not only meet academic benchmarks of technical rigor and presentation quality but also elevated the students' capacity to connect, empathize, and create with a user-first mindset. These experiences are critical in preparing future architects for the evolving demands of inclusive, data-driven, and emotionally intelligent design practices.

Challenges and Limitations

While the integration of AI tools and fictional character narratives significantly enriched the design studio, several challenges and limitations were encountered throughout the process. These limitations highlight the need for balanced pedagogical strategies and infrastructural support to ensure long-term efficacy and scalability.

- **Fictional Characters and Bridging Imagination with Reality**

Designing for fictional or animated characters served as a powerful pedagogical tool to deepen students' understanding of space-making through anthropometric analysis and user-centric design. This approach enhanced their grasp of architectural spatial relationships by encouraging empathy and imaginative exploration. However, to ensure the work remained grounded in professional realities, the studio incorporated a real-world site, enabling the integration of tangible constraints such as Floor Area Ratio (FAR), local building byelaws, and regulatory frameworks. While some students initially gravitated toward overly fantastical solutions, faculty guidance helped redirect their creativity toward feasible and structurally logical outcomes. This dual focus allowed students to push the boundaries of their creative thinking while applying it within the constraints of actual architectural practice.

- **Limited Access to Advanced AI Tools**

Despite the growing availability of AI in design education, full integration was hindered by restricted access to premium or high-performance AI platforms. Many of the advanced tools required expensive licenses, powerful hardware, or institutional support that was beyond the scope of the studio's resources. As a result, students had to rely on basic or trial versions of software, which limited the depth and precision of their analysis, particularly in areas such as environmental simulation, generative design, or predictive behavioural modelling. This technological gap created discrepancies in outcomes based on the tools accessible to each student.

- **Steep Learning Curve for Emerging Technologies**

The studio introduced a suite of new AI-driven and immersive technologies—ranging from schematic generators to virtual reality visualization platforms. While these tools enriched the design process, they also posed a steep learning curve, especially for students unfamiliar with computational workflows or advanced digital modelling environments. Initial sessions often required additional time for technical onboarding, troubleshooting, and confidence-building. In some cases, the technological complexity overshadowed creative exploration, particularly among students who were more traditionally trained or apprehensive about digital experimentation.

- **Balancing Creativity with Technical Rigor**

A recurring challenge involved balancing open-ended narrative exploration with the technical rigor expected in architectural education. The creative freedom offered by AI-generated prompts and character-based storytelling occasionally diverted focus from fundamental architectural principles such as structure, climate responsiveness, and construction methods. In response, the studio integrated checkpoints and review rubrics to recalibrate designs against performance metrics, ensuring that narrative richness did not compromise design integrity.

- **Assessment Complexity**

Evaluating student outcomes in a hybrid AI-narrative framework posed its own set of difficulties. Traditional grading criteria often fell short in capturing the interdisciplinary and experiential aspects of the projects. Faculty had to rethink assessment models to account for creativity, innovation, storytelling, technical feasibility, and responsiveness to AI-generated feedback. This complexity demanded more nuanced, multi-dimensional evaluation tools and consistent peer reviews.

Conclusion: The integration of artificial intelligence and narrative-driven pedagogy in architectural education has opened new pathways for design thinking and student engagement. By leveraging AI tools to craft immersive narratives and personalized design experiences, students not only developed deeper empathy for their users but also honed their skills in conceptual thinking, visual storytelling, and technological integration. This approach bridged the gap between abstract user needs and concrete design solutions, fostering a more human-centred design methodology. The case study demonstrates that AI, when used thoughtfully, can enrich studio pedagogy, inspire creativity, and prepare students for a future where technology and empathy must go hand in hand in shaping the built environment.

REFERENCES

1. Autodesk. (2020). *Generative design: Streamlining iteration and innovation*. Retrieved from [autodesk.com: https://www.autodesk.com/solutions/generative-design](https://www.autodesk.com/solutions/generative-design)
2. Burry, M. (n.d.). *Scripting cultures: Architectural Design and programming*. In Wiley, *Scripting cultures: Architectural Design and programming*. AD Primers.
3. Cole Stryker, E. K. (2024, AUGUST 9). *IBM*. Retrieved from IBM: <https://www.ibm.com/think/topics/artificial-intelligence>