BINDING AI AND XR IN DESIGN EDUCATION: CHALLENGES AND OPPORTUNITIES WITH EMERGING TECHNOLOGIES

Christiam MENDOZA-GARCIA, Daniel MUÑOZ-GUZMAN and David SANCHEZ-RUANO
Tecnologico de Monterrey, Mexico

ABSTRACT

Our Design Program at Tec de Monterrey is progressively incorporating Artificial Intelligence (AI) tools, further enhanced by Extended Realities (XR), into our pedagogical practice. This innovative consolidation primarily improves the conceptualization stage of the design process. As students mature in their design intelligence, they harness AI to iterate and visualize alternatives, enriching their decision-making discussions with various project stakeholders. This led to the swift creation of physical prototypes across three distinct categories, each with their unique briefs. Vizcom AI emerges as the most utilized tool, a 2D-rendering platform that refines outputs based on initial sketches and user prompts. Complementary tools aid in navigating the convergence of design and technology education, including VR modelling, AR, and electronic systems simulation. Collectively, these technologies accelerate the design process. However, it is worth noting a consequent limitation in the development of basic analog design abilities, especially affecting the understanding of space and spatial intelligence. Students reported their learning experience with these technologies, along with their expectations and concerns. As we continue integrating these technologies into design education, we have identified the opportunity of leveraging VR to enhance spatial intelligence comprehension, while preserving AI's benefits. This study acts a base to develop new teaching and learning practices that support our students' professional future in an evolving design landscape with these transformative technologies.

Keywords: Extended reality, design, virtual reality, higher education, educational innovation

1 INTRODUCTION

1.1 Current interest in virtuality and artificial intelligence

Over the last 10 years digital technologies have been evolving to adapt to the rapidly changing manifestation of virtual worlds. On this realm education plays a vital role in providing students with tools that can help them to solve projects by conceptualizing and prototyping. The arts and the sciences have been exploring the use of virtual reality (VR) making it more accessible [1] not only in academia but also in commercial and social contexts. Another aspect is the emerging use of artificial intelligence (AI) in everyday life. The increasing systemic connectivity of data, coding, and sophisticated devices to visualize and process images have created an improvement in learning environments [2]. Design disciplines are taking advantage of these technologies consolidating the profession.

1.2 Design for XR y VR technologies

The design process for XR experiences introduces a range of unique considerations and challenges compared to the traditional design process, requiring specialized tools, testing methods, and a focus on creating immersive, spatially aware experiences for users. Table 1 compares several aspects of the design process in traditional and XR environments.

Table 1. Comparison of the design process in traditional and XR environments

Aspect	Typical Design Process	XR Experience Design Process
User Interaction	Primarily 2D interfaces	3D and spatial interaction
Environment	Limited to physical or digital interfaces	Immersive and interactive environments

Tools	Traditional design software	Specialized tools for XR development
Testing	Screen-based testing and feedback	Real-time user testing in XR environments
User Experience Focus	Visual and functional aspects	Immersive experience and spatial awareness
Iterations	2D mock-ups and prototypes	3D prototypes and immersive simulations
Motion and Interaction	Limited to mouse, keyboard, or touch input	Gestures, gaze, and spatial tracking
User Perspective	Observer perspective	User's own perspective within the XR space
User Comfort Consideration	Limited to screen size and clarity	Consideration of motion sickness and comfort in immersive environments

1.2.1 Considerations for the design process

The use of XR is highly used in teaching design, but it also can be used in the design process in phases like virtual prototyping, immersive design reviews, interactive exploration, training, simulations, and client presentations. On the other hand, AI is even more used as part of the design process, like generative design, predictive modeling, writing with NLP assistance, image and style recognition, customization, prototyping, testing and the most used: image generation for exploration and iteration [3], as part of the design process.

1.2.2 Platforms

Gravity Sketch is a 3D modeling software that revolutionizes the design process by enabling users to create immersive, three-dimensional experiences in virtual reality (VR). This innovative platform allows designers and creators to craft intricate models and concepts using natural hand gestures and spatial understanding, breaking free from the constraints of traditional 2D interfaces. With its intuitive and collaborative features, Gravity Sketch allows users to ideate, iterate, and visualize their designs in a truly immersive environment, redefining the boundaries of digital creation and opening up new possibilities for spatial design and prototyping.

Meta Spark Studio is a platform for crafting XR experiences, offering a seamless and intuitive environment for creators to build immersive content. It empowers designers and developers to bring their ideas to life in virtual and augmented reality. The platform’s robust features enable the creation of spatially aware experiences, interactive environments, and lifelike simulations, fostering a new era of storytelling and user engagement. By providing access to advanced capabilities for spatial computing and sensor integration, Meta Spark Studio has become a tool for innovators looking to push the boundaries of XR design and deliver captivating experiences across a variety of industries.

FrameVR enables creators to craft immersive 3D environments with ease. The platform’s emphasis on collaboration allows multiple users to simultaneously design and interact within the virtual space, fostering real-time creative exchange and reducing the barriers to teamwork. By providing a range of customizable assets, spatial design elements, and interactive features, FrameVR empowers users to bring their vision to life in a truly immersive environment, making it an invaluable tool for designers and creative teams seeking to create compelling virtual experiences.

Tinkercad offers, among its suit of functions, an accessible and user-friendly platform for simulating electronic circuits. Its intuitive interface allows users to seamlessly drag and drop components, connect them with virtual wires, and experiment with various circuit configurations without the need for physical components. Tinkercad’s extensive library of electronic components enables users to simulate a wide range of circuits, from simple LED circuits to complex microcontroller-based designs. Additionally, its simulation feature provides real-time feedback on circuit behavior, allowing users to visualize electric properties and component interactions, providing a valuable learning experience for those looking to understand and experiment with electronics in a virtual environment.

1.2.3 Generative AI for (product) design

Though numerous generative AI tools and services primarily concentrate on delivering enhancements and alterations to visually created content by humans, they frequently generate variations in visual style rather than the concepts depicted in the image. Effectively exploring the design realm demands innovative thinking, originating from the exploration of significantly unique ideas. Nevertheless, these ideas are vulnerable to, and frequently shaped by, the designers' intuition, expertise, and predispositions regarding the subject [4] providing room for innovation.

Systems for translating text into images empower designers to swiftly convert imagined ideas into lifelike design representations within seconds. Yet, incorporating prompt engineering-driven design into business operations poses challenges due to the mentally demanding process of transforming designers' visual concepts into textual expressions. This transformation requires expressing intended meanings with clarity and recalling the specific design ontology acknowledged by the generative model. Consequently, this issue gives rise to text prompts that produce image depictions incongruent with the designer's envisioned visual concept, or vice versa, thereby necessitating considerable time for iterative prompt refinement until the desired outcome is attained Ben Hutchinson et al [5], seen as a new type of competences for design and engineering students.

2 LEARNING CONTEXT

The experimentation with emerging technologies occurred in three different use cases with different briefs presented to Design students. All briefs led to the creation of physical prototypes, underlining the connection between the creating with and within digital tools for the physical world.

2.1 Digital communication for products

The aim of this intermediate design course is for students to know and use digital representation and communication media in the different product design phases. General concepts of 2D and 3D digital representation and communication, and digital manufacturing of the product are included. No prior knowledge is required. The expected learning outcome is for students to execute the digital representation of a specific product in the different design phases for its integral communication. The challenge for the student was to create a toy model of herself, like the Funko Pop toys. The process took them across sketching, 3D modelling, 3D printing their toys, and packaging it. One condition was that they had to use AI during the ideation design process and for the rendering visuals.

2.2 Technological integration

The aim of this advanced design course is for students to develop high added-value, technology-based innovation solutions. Prior knowledge is required of composition and representation, basic ergonomics, digital modeling software management, selection and use of materials, and basic graphic production and design processes. The learning outcome is for students to integrate viable technological design projects that are committed to client expectations. The challenge for students was to create new tools to connect the physical world with a VR environment used for industrial training. Students used AI to quickly ideate alternatives for an industrial partner to quickly make decisions that guided the design process to better fulfil the expectations.

2.3 Emerging technologies and digital transformation

The aim of this advanced design course is for students to formulate competitive design proposals and management models for innovation. Prior knowledge is required of composition and representation, basic ergonomics, digital modeling software management, selection and use of materials, and basic graphic production and design processes. The learning outcome is for students to develop solutions by integrating Industry 4.0 technologies that generate industrial property. The challenge was to create AR experiences for children’s stories. Along the process, students co-created with different AI tools and used AR tools to build and distribute the experiences.

2.4 Intelligent materials

The aim of this advanced design course is for students to learn about intelligent materials, meta-materials, and biomaterials to visualize new product design opportunities. Prior knowledge is required of 3D printing and laser cutting, and the associated software. Learning outcome: Students conceive products by taking advantage of the responsive characteristics of intelligent materials so that they can be activated in specific circumstances to solve real-life problems. Students worked in the MAZDA Automotive Design Challenge, where they had to design smart cars using smart materials. One condition was that they had to use AI during the ideation design process.

3 EXPERIMENTATION, APPLICATION, AND EXECUTION FOR AI AND XR

3.1 Using Vizcom

Within the realm of creative ideation, students traditionally engaged in the generation of a series of manual sketches to delve into ideas, colours, volumes, and other design elements. This undertaking consumed approximately 8 hours, necessitating meticulous efforts to attain high-fidelity sketches and comprehend each facet of the diverse ideas or iterations they developed. In formulating a hypothesis, the proposition was made that the incorporation of artificial intelligence could enhance efficiency and expedite the completion time of this process. To test this hypothesis, students employed a generative AI framework. They integrated their preliminary sketches with a well-crafted prompt, and the AI took charge of rendering detailed images swiftly, thereby facilitating a more expeditious progression through the ideation process.

In the experience of working together with industrial partners, their expectation is to see the concepts and digital representations of potential solutions after 3 or 4 weeks of guided student work. For one of the educational experiences presented, students were able to present their first digital representations in just 4 days, aided by AI tools. This provided the industrial partner with greater visibility of the process which resulted in much better feedback for students. This impacted in greater satisfaction of both students and the industrial partner.

3.2 3D Modeling to generate ideas

We use the software Fusion 360 for 3D modeling teaching. Here we apply AI for generative design, where students try different shapes to reduce material from the object aided with the AI. Younger students use AI to make renders from their 3D models, being able to change colour and materials faster.

4 CONCLUSIONS

The current advancements in Design Education emphasize the integration of new technologies, particularly artificial intelligence (AI), in various design courses. Students are now engaging in creating digital representations of products using 2D and 3D design concepts, digital manufacturing, and AI-driven ideation processes. This integration is exemplified in projects where students design personalized products, incorporating AI during the creative process. This integration extends to advanced design courses, highlighting the importance of technological assimilation and the application of industry 4.0 technologies, leading to high-value, technology-based solutions.

In addition to digital design and AI, Design Education is evolving to include the exploration of innovative materials. Students delve into the field of intelligent materials, meta-materials, and biomaterials, which necessitates a solid expertise in 3D printing and laser cutting. AI's role extends beyond ideation to 3D modeling, where software like Fusion 360 is used for generative design. Younger students are leveraging AI to streamline rendering processes, facilitating quicker experimentation with colour and materials.

Despite the significant strides in integrating digital technologies and AI in Design Education, a key challenge lies in maintaining the development of basic analog design skills. These skills, such as understanding space and spatial intelligence, are fundamental to design. Therefore, while the incorporation of AI and digital technologies is substantially enhancing efficiency, accelerating design processes, and fostering innovation, it is crucial to address this potential limitation to ensure a well-rounded development of students in the field. In summary, Design Education is rapidly evolving, driven by AI and digital technologies, but it is essential to maintain a balance with traditional analog design skills for holistic student development.

ACKNOWLEDGEMENTS

The authors thank Writing Lab, Institute for the Future of Education, Tecnologico de Monterrey, Mexico, for the financial support in the production of this work.

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