26TH INTERNATIONAL CONFERENCE ON ENGINEERING AND PRODUCT DESIGN EDUCATION
5-6 SEPTEMBER 2024, ASTON UNIVERSITY, BIRMINGHAM, UNITED KINGDOM

USE AND APPLICATION OF GENERATIVE AI IN MULTIDISCIPLINARY PROJECTS: LUNAR HABITACLES, AUTOMOTIVE CONCEPTS AND FUTURE SOUVENIRS

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ABSTRACT
Artificial Intelligence is currently experiencing a period of "inflated expectations", according to Gartner and its Hype Cycle report on Emerging Technologies, August 2023. As part of this scenario, this article describes and analyses the exploratory approach and implementation of AI in three projects developed in 2023, in three different areas of the Tec 21 Educational Model of the Tecnologico de Monterrey: A five-week challenge with international partners and collaborators; a "Novus" fund for educational innovation, and a transversal subject of creativity and innovation for engineering and business students. In all of them, the use and application of Generative Artificial Intelligence contributed significantly – and in new ways – to the fulfilment of their objectives, as well as with new possibilities and reflections on their implications in the teaching-learning processes and the academic quality of their results. The range of exploration and development processes with Artificial Intelligence used, fed by sketches, 3D models or prompt engineering as a 'stimulus', showed from their use possibilities to detonate the formal genesis of architectural proposals for the exploration of different alternatives, accelerate the iteration phase in the creative process to design a car, and reduce the time and learning curve for the generation of digital representations or "renders". From these results, reflections on new emerging cognitive processes in students using AI, as well as reflections on possible implications and challenges in its approach from Latin America, could be extracted.

Keywords: Higher education, professional education, educational innovation, artificial intelligence, design

1 INTRODUCTION
In 1975, in a publication called Edugrafología [1], while reflecting over the inherent qualities of human beings, Víctor Papanek argued that what "healthy" people do is design, in reference to the imaginative and creative capability of making decisions projected into the future, with the intention of influencing it and producing a desired outcome. Although this is true at its fundamental level, as these creative "projectual" processes inherent to designing became more specialized for certain desired outcomes (e.g. designing industrial products, houses, cities, etc.), they also became less accessible to a majority of individuals who did not choose to specialize in these traits, a matter aggravated by the fact that, currently, not even fundamental cognitive traits in design (e.g. project thinking, anticipated planning) are taught in most schools at primary and secondary education, leaving most of the students at this stage with a fairly limited domain of design capabilities in general.
More recently, however, with the arrival and peak of inflated expectations of Generative Artificial Intelligence [2], the creative process for generating new products becomes a much simpler and faster procedure for novice undergraduate students, enhancing their understanding and development of cognitive skills in design, by reducing the learning curve and generating less frustration while obtaining better results in less time. Likewise, for more experienced designers, this expands and accelerates the

iteration and formal exploration phase, generating a virtuous feedback loop for continuous improvement in new product development. As we have seen, the incorporation of AI in education has evolved rapidly in recent years [3], [4], along with several studies carried out on the potential impacts of AI on Education, over the last decade [5]. Hence, it is important to highlight that the growth of AI implementation in education is being accompanied by critical reflections over its ethical implications [6], [7].
This paper thus presents and critically analyses the case of three projects in design education that reflect an interlacement of the phenomena previously described. The projects employ the double diamond as methodological model [8], and specific design-related tools such as sketching, virtual modeling, and 3D printing, plus the incorporation of generative artificial intelligence, with the aim of introducing engineering and design students to a virtual environment which allows for their exploration of the possibilities of AI as a useful tool within their creative process [2], [9].

2 METHODOLOGIES

As mentioned above, the double diamond model is the methodological basis for this descriptive, exploratory, and comparative work, where the use of Generative Artificial Intelligence is a common denominator among the three design projects.
In Figure 1 it can be seen how in the three projects based on the diamond model, AI is used in the divergent phases of both processes, first in the discovery phase, from an extensive ideation where the objective is to explore all possible forms and combinations, only to give way to the definition of the one that brings us closer to the desired objective and, move on to a second phase of iterations on the same idea, with the intention of improving it, detailing it and preparing it for final delivery.

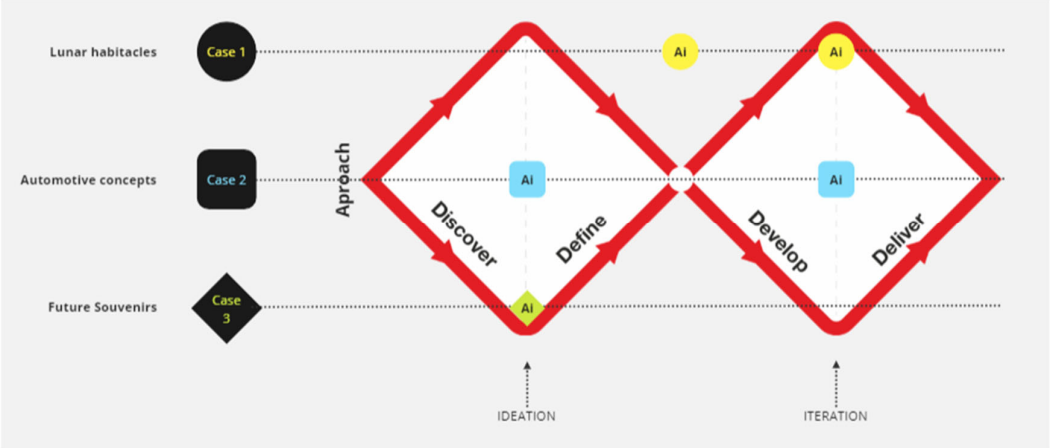

Figure 1. Use of AI through the creative process in three different academic projects

The following sections will describe in detail the three projects and the way in which AI was used as part of their creative process.

2.1 Case 1

The Formal Representation of Space "block" [10], the Tec 21 Model aims for students to design sensory rooms. The objective of the course is to promote, from the design, multidisciplinary critical dialogues that address the understanding of space through sensory perceptions and its material and virtual representation with the purpose of exploring multiple narratives. Concept, design, representation, materialization, and experimentation of a sensory room that inspires storytelling.
The methodology is made up of five stages, divided into five weeks: Experimentation and Analysis, Conceptualization, Synthesis, Enforcement and Delivery. At the start-up, they are introduced to their training partners and collaborators, who, in turn, present them with the brief of the challenge, its requirements and parameters. During the development of each of the stages, the student must have a log where they capture their ideas, concepts, and design process in a graphic way. In this process, students need to iteratively practice drawing techniques that are practiced as procedural content, as well as other experimental techniques.

Phases three and four are where AI is used as a tool for ideation and iteration, as can be seen in Figures 2 and 3, respectively.

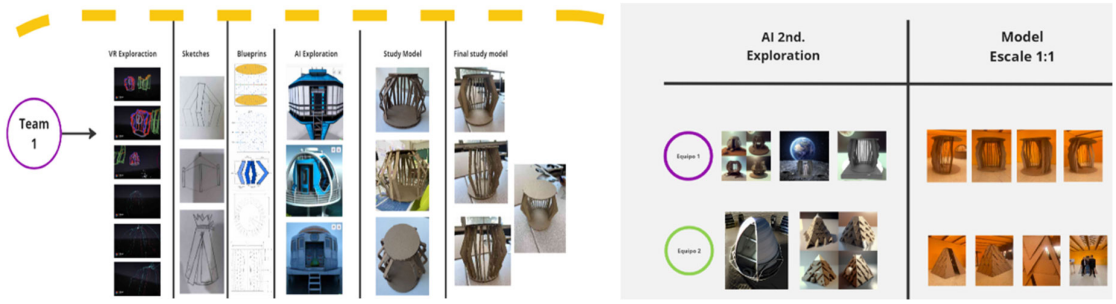

Figure 2. and 3. AI applied in the ideation and iteration processes

2.2 Case 2

On the other hand, and with the support of the Novus Fund for Educational Innovation [11], virtual and physical car models are being developed for a virtual car assembler [12], and this project began in February 2023 and will end in May 2024. The ultimate intention of this innovation is the development of skills related to the integration of emerging systems and technologies in Engineering and Design professional students.

The development of the models was based on the Double Diamond Model of the British Design Council [8]. The initial formal exploration of the car proposals (two and four seats) was carried out through photographs and sketches; Later, through several iterations in the process, different alternatives were developed produced by two different Artificial Intelligences: Midjourney and Deep Dream Generator. These proposals were reviewed by the design team to determine the best proposal that contains the required requirements and parameters. Figure 4 summarizes the design process of the two-seater car, with the support of AI and based on the Double Diamond model. Figure 5, for its part, presents the development of the four-seater car, based on the design obtained in the interior process.

Figures 4. and 5. AI assisted double diamond model

In this application of AI, for the development of original automotive models, we believe that it will be well accepted among Industrial Engineering and Product Design students. The above through hybrid learning experiences (digital and physical).

2.3 Case 3

As part of the general education subjects at the professional level, Tecnológico de Monterrey offers a subject of Innovation and Creative Processes in which, one of its problem situations, the development of prototypes for a specific situation, related to physical inactivity as a global health problem, is offered. In the August-December 2022 semester, this project was developed integrating a participatory futures model called Tenkua [13], as a methodology for obtaining these speculative objects. Subsequently, in the August-December 2023 semester, a new group of students was presented with the same project with two new variables: the use of artificial intelligence and the methodological basis of a conceptual exercise called Souvenirs of the Future [14].

The group begin this work based on documentary research on physical inactivity and its various repercussions on people's health, ranging from disorders such as obesity or diabetes, to anxiety or depression. Once this research has been done, the students select a specific situation that may be feasible to solve hypothetically and conceptually, through the souvenir of the future that they design individually. Once they know the context of the problem they want to focus on and know all the variables to consider, they elaborate a 300-word text that helps them generate a prompt, which serves as a bridge between what is desired and what is obtained through different ideas exploration using artificial intelligences such as Leonardo. Adobe Firefly, Bing, Craiyon, Canva, and DreamStudio.
The result is a digital image that is detailed as a render and that manages to explain in a clear and visual way what the students captured in their text. The artificial intelligences used are free, some with a credit limit per day or with paid options to access their premium version, but, without a doubt, all of them, an excellent creative tool for representation and visual communication, which added to other online tools such as Miro or Canva, provide students with an accessible and easy way to generate quality products such as posters, for the presentation of their results and final project deliverables.

3 RESULTS

The results obtained in the implementation of the three cases are presented below.

3.1 Results of case 1

The challenge for the 33 students of Creative Studies ended with their exhibition in one of the largest museums in the city of San Luis Potosí, the Labyrinth Museum of Sciences and Arts. Family, friends, and academic authorities were able to appreciate the result of five weeks of work. In Figure 6 can be seen the final delivery, this consisted of the presentation of the 1:1 scale model, a poster with the explanatory video and the 300-word text previously developed, as well as a QR code with a descriptive audio of the project and elements in Braille, so that blind and partially sighted people could learn about the project, thus closing this collaboration between inclusive design, technology and studies of possible futures.

Figure 6. Poster and 1:1 scale model of Lunar Habitacles

3.2 Results of case 2

Even though the project of this case 2 is in process, results can be observed from the implementation of the DDM, with the support of AI applications such as Midjourney, Leonardo and Vizcom, as well as the Rhinoceros 3D software and 3D printing with Stratasys and Anycubic equipment. As in any product design process, it is important to use 2D/3D drawing and virtual visualization tools, as well as validation prototypes throughout the process. Below, in Figure 7, you can see examples of the visualizations and 3D prints of the car development process.

Figure 7. Examples of the visualizations and 3D prints of the car development process

As mentioned above, the use of artificial intelligence applications was of great help in the development process of the two car models. It is also important to mention that several iterations were carried out with these applications, each time obtaining a more appropriate version that adhered to what was initially planned.

3.3 Results of case 3

The project was called "The Third Moment", alluding to the fact that this was the last of the three projects developed by the students in the semester. It is motivating for students to present their projects outside the classroom, as it becomes an important goal and commits the group to ensure that the quality of their work is at the level of an exhibition. In this case, we can see in Figure 8 what they developed, a poster and a model of their souvenir, all presented on a cardboard base with a display. The gallery that provided us with the space was the Central State Library, part of the San Luis Potosí Railroad Museum.

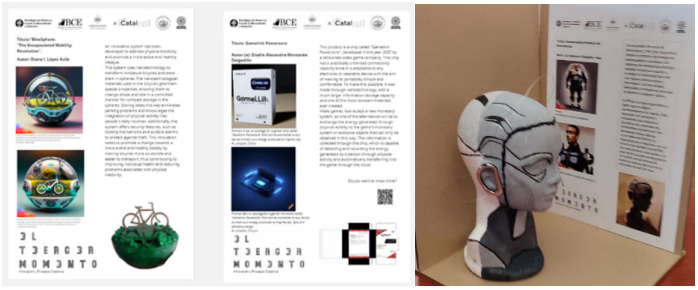

Figure 8. Poster display and prototypes of the Futures Souvenirs

4 DISCUSSION AND CONCLUSIONS

Based on the results of the implementation of generative AI in these three cases, we were able to observe that the AI model and the students co-designed their intended products through a series of iterations until the final design was deemed satisfactory. Such a process drastically reduces the technical skills required by students to produce high-fidelity images, while proposing a new emerging cognitive skill that refers to the "curation" of the cues chosen by them in each iteration. Thus, the result is obtained through a combination of hundreds or thousands of "micro design decisions" made by students and AI, the former through words and sentences, the latter through images and representations.

From this, we can affirm that the application of this technology streamlined the processes of exploration and validation of the first ideas, which made generative AI an effective tool in divergent stages of the design process, accompanied by precise and appropriate input from the human counterpart. Thus, creativity is shared between the human and the AI, redefining "what's possible" by combining the AI's database and the human's experiences, memory, and references, assisted by the internet.

In addition, it is key to consider the ethical implications involved in the use of generative AI, with the aim of achieving a balance between innovation and responsibility, where there is a clear ethical framework that encourages the productive use of this technology as a democratizer and enhancer of human design capabilities.

It is important to consider then that AI models are based on databases that contain human knowledge available in digital form, present in disproportionate quantities with respect to different geographies of the world, and that also include their normativity and biases. Therefore, biases in relation to gender issues, anthropocentrism, or modern Western hegemonic worldviews, among others, are also going to be replicated and projected by AI. Therefore, it is particularly relevant that, when using this tool in very diverse multicultural contexts, with coexisting worldviews, behaviours and lifestyles that occupy the same territory, as is the case of Latin American countries and cities, users continue to be critical of the visions projected by AI, since the results could strengthen such biases that position one cultural perspective over others. Consequently, these inherent features and limitations of the tool must be critically addressed, to ensure that the results obtained are truly beneficial to all individuals and populations involved.

In line with the above, the contributions that were developed in the Formal Representation of Space block arose from the dialogues, curatorship and critical reflections that served to interpret the context of

the project and establish proposals that contribute to the promotion of human dignity, having the co-creative imagination as a vehicle for the design of desirable futures.
Although the initial description of the use of AI in the cases mentioned above may seem limited, this first foray into the Latin American context perhaps focuses its lens on emerging cultural issues and sets a precedent for more in-depth research and applications in the future, including exploratory comparative studies between Latin American countries such as Mexico and Peru. We agree that it is essential to recognize that these initial implementations of AI in design in such contexts involve quite particular processes of learning and cultural adaptation, both designers and of the tools themselves. The intention to re-implement AI in future projects, with the aim of conducting comparative studies and expanding the sample, demonstrates a methodological approach of improvement, to avoid falling into an excessive dependence on AI.

ACKNOWLEDGEMENTS

The authors wish to acknowledge the financial support of the of the Writing Lab, Institute for the Future of Education, Tecnologico de Monterrey, Mexico, in the production of this work. The authors acknowledge the financial support of Novus Grant with PEP No. PHHT085-22ZZNV064, TecLabs, Tecnologico de Monterrey, Mexico, in the production of this work.

REFERENCES

[1] Papanek V. *Edugrafología: los mitos del diseño y el diseño de los mitos. Bierut, M., Helfand, J., Heller, S, Poynor, R. Fundamentos del Diseño Gráfico,* 1975 *(*Buenos Aires: Infinito).
[2] Kadaruddin K. Empowering education through generative AI: Innovative instructional strategies for tomorrow's learners. *International Journal of Business, Law, and Education*, 2023, 4(2), 618-625.
[3] Guan C., Mou J. and Jiang Z. Artificial intelligence innovation in education: A twenty-year data-driven historical analysis. *International Journal of Innovation Studies*, 2020, 4(4), 134-147.
[4] Ronquillo K. K. M., Pérez L. D. R. P., Veloz J. F. A. and Solís R. L. F. La inteligencia artificial aplicada en la innovación educativa en el proceso de enseñanza y aprendizaje: Artificial intelligence applied to educational innovation in the teaching and learning process. *LATAM Revista Latinoamericana de Ciencias Sociales y Humanidades*, 2023, 4(2), 1597-1613.
[5] Zhai X., Chu X., Chai C. S., Jong M. S. Y., Istenic A., Spector M. and Li Y. A Review of Artificial Intelligence (AI) in Education from 2010 to 2020. *Complexity*, 2021, 1-18.
[6] Kadaruddin K. Empowering education through generative AI: Innovative instructional strategies for tomorrow's learners. *International Journal of Business, Law, and Education*, *4*(2), 618-625, 2023.
[7] Naqvi M. Ethical Implications of AI in Modern Education: Balancing Innovation and Responsibility.
[8] Tschimmel K. Design Thinking as an effective Toolkit for Innovation. *In ISPIM Conference Proceedings* (p. 1). ISPIM, 2012.
[9] Hwang A. H. C. Too late to be creative? AI-empowered tools in creative processes. In *CHI Conference on Human Factors in Computing Systems Extended Abstracts* (pp. 1-9), 2022, April.
[10] Villanueva A. *El ABC del Modelo Tec21 del Tecnologico de Monterrey.* Available: https://conecta.tec.mx/es/noticias/nacional/educacion/el-abc-del-modelo-tec21-del-tecnologico-de-monterrey [Accessed on 2024, 5 March], (2019) 19 August.
[11] *Novus, Institute for the Future of Education.* Available: https://novus.tec.mx/en Accessed on 2024, 19 February], (2021).
[12] Vázquez R., Acuña A., González C., Peñalva J., Corona C. and López C. NEW AUTOMOTIVE AND AERONAUTICAL MODELS AND DESIGN OF DIGITAL TWINS TO SUPPORT LEARNING IN TEC21 EDUCATIONAL MODEL. In *DS 123: Proceedings of the International Conference on Engineering and Product Design Education (E&PDE 2023),* 2023.
[13] Cornejo P. K. A. "Tenkuä: Designing Futures for Broken Cities". *Temes de Disseny*, 2020 (36), 178–191.
[14] Cardini P. and Paniagua K. *The global futures lab observatory envisions a future shaped by non-western voices.* (s/f). Core77. Available: https://www.core77.com/posts/101125/The-Global-Fu-tures-Lab-Observatory-Envisions-a-Future-Sha-ped-By-Non-Western-Voices [Accessed on 2024, 2 March], (2020) 4 August.