# USE OF ARTIFICIAL INTELLIGENCE IN THE PRODUCT DESIGN PROCESS. IMPACT ON THE DETAILS DESIGN STAGE

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## ABSTRACT

Product design involves a set of stages; many methods may be used to resolve the different stages of the process, which are conditioned by the nature of the project or its magnitude. However, introducing artificial intelligence (AI) tools has significantly simplified this process. This research aims to identify the impact of one such tool, the Gencraft® artificial intelligence tool, applied in the details design stage and its implications in the teaching-learning process of students pursuing the Bachelor of Design degree. To achieve the research purpose, a sample of 22 students (two groups) in the sixth and eighth semesters of the Bachelor of Design program at Tecnologico de Monterrey, Mexico, was assembled to use the Gencraft® tool in the details design stage of their projects. After the exercise, the students responded to a survey-type instrument to assess the tool's impact and potential in the design process. The analysis of the responses identified that most students in both groups agreed that the tool could have much value in the conceptualization or ideation stage because the generated images look like product renders. This research affirmed that the artificial intelligence tool used was perceived positively by the students in their learning process as valuable and facilitatory in product design.

*Keywords: Design process, Artificial Intelligence, CMFs, educational innovation, higher education*

## 1 INTRODUCTION

Due to the advances in Artificial Intelligence (AI) technology, generating images for different uses has been successfully simplified by giving textual instructions ("prompts") [1], [2]. This ability has led to the development of innumerable applications, ranging from art to education at different levels. Many of these tools allow going from text to image, offering excellent quality and making the interpretation of the prompts easier by writing with natural language [3]. In the case of education, generative artificial intelligence (GenAI) such as ChatGPT (Chat Generative Pre-trained Transformer) [4] and others have revolutionized how activities are carried out inside and outside the classroom, raising essential questions about what and how a subject is taught, why, by whom, and who does the work, in a constant search for efficiency; thus, over the years, many technological tools have shaped the answers to these questions and conditioned the primary purpose of education [5], [6].

These questions did not arise only with the emergence of Artificial Intelligence in Education (AIED) [7]. The slide rule, the calculator, the computer, and computer-aided design (CAD) [8] are other technological developments that have impacted education. Their use was initially prevented until they became necessary and mandatory within the teaching-learning process. The concern was not whether or not to use the tool, but how well a teacher knew to use it or how capable they were of leveraging it, that is, being as efficient as possible.

Like any technological proposal, AI still presents challenges, barriers, and opportunities to address from many perspectives [4]. In this sense, design (product, graphic, visual, industrial, engineering, etc.) is a professional discipline significantly impacted by this technology; it seeks to achieve the expected efficiency. With this premise, Huang et al. [8] suggest that AI can impact design through three "horizons": (i) in the approach of new sensory experiences, (ii) in the generation of new products or services that are conceptually different and (iii) in the reinterpretation of how people live and relate to the environment.

The product design process involves stages that generally start from detecting a problematic situation, a user's need, a client's requirement, etc. [9], [10]. However, many methods can be used to resolve the different stages of the process, which are conditioned by the project's nature or its magnitude [11], [12]. Hanington y Martín [13] propose dividing design methods into five phases: (1) planning, scope, and definition; (2) exploration, synthesis, and design implications; (3) concept generation and first iterations; (4) evaluation, refinement, and production, and, finally, (5) a launch and monitoring phase. Moreover, besides the phases of the design process, in all cases, the time will come when the colour, materials, finishes (CMFs), or final product appearance must be defined [15]; therefore, there is a tendency to make iterations of the possible combinations of these elements with the idea that the product achieves the function as expected, that the user can interpret and perceive it in the way desired by the designer [14], and that it also meets the specifications or technical-productive requirements previously raised [9]. Likewise, in many universities, Product Design students usually receive a brief document that presents critical elements that must be met in the project [15], to which is generally added the link with a real user, a client, or a project applicant (also real), with imperative conditions that the final product must meet. At this point, specific artificial intelligence (AI) tools can impact by simplifying the process. In particular, this research aims to identify the impact of applying the Gencraft® Artificial Intelligence tool for image generation in the detailed design stage (CMFs) and its implications for the teaching-learning process of students studying for the Bachelor of Design [8].

## 2 METHODOLOGIES

To begin this work, a literature review was conducted on using artificial intelligence in the teaching-learning process and the methods associated with the product design process [16], from which the main research question emerged. Once the purpose of the research was identified, a search was carried out for AI programs that could support the design process at some stage. From this search, the possibility of using Gencraft® for the Detail Design stage arose, considering that it is a tool that (i) offers excellent graphic or visual results and (ii) allows generating ten images daily for free. By this point, the students already had a clear conception of their proposed product. They had developed it without using AI in any previous stage of the process, so using the tool would not determine the product's general configuration but its appearance.

To achieve the research purpose, a sample of 22 students (two groups) in the sixth and eighth semesters of the Bachelor of Design program at Tecnologico de Monterrey, Mexico, was assembled to use the Gencraft® tool in the details design stage of their projects, defining their CMFs. The students had developed their project as a team, but for this exercise, they were instructed to generate the images individually and each to decide the prompts they would give to the tool. They were asked to query the tool to create an image of their product, starting with only three prompts. Then they generated a new image, but this time with four prompts, and so on, to generate images from a total of 12 prompts, thus completing the maximum daily amount that the tool allows for free (10 images) with the idea that the generated images would look increasing more like the product they had designed. Thus, the prompts were refined so that the result continuously improved; the students paid particular attention to the colours, materials, and finishes (CMFs) [15] the tool produced in the images. After generating these, the students selected the CMFs they considered most appropriate for the product based on the design requirements they had established from the brief. Once the exercise was completed, a survey-type instrument was applied to the students [11], having four main themes: experience with the technology, ease of use, perception of image quality, and perception of the tool's value; the purpose was to assess students' perceptions of the impact of using the tool and the potential it could have in the design process based on their experience.

## 3 RESULTS

### 3.1 About the application of the AI tool

As previously explained, the students individually generated ten images. Sometimes, these images increasingly resembled the initially designed product; however, in some cases, they exhibited no logical evolution but instead reflected something completely different as the prompts were added, possibly due to the students' lack of knowledge about the technology and lack of experience in using it, that is, not knowing the correct prompts to obtain the best result [1]. Below are three examples of image groups generated for each project and a brief explanation of each:

Table 1 shows the first example: the prototype made by the students, followed by some of the images created with AI, where comparisons help define the tool's contribution. This project consisted of a foot therapy product for older people.

*Table 1. The sequence of images generated by AI: Example 1*

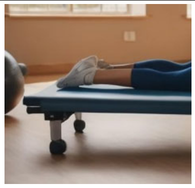
| Student prototype | 3 prompts | 6 prompts | 8 prompts | 11 prompts |
|---|---|---|---|---|
|  |  |  |  |  |

Table 2 shows another sequence of images generated by AI. In this case, the project was a set of activities and products for occupational therapy representing objects of daily use in traditional Mexican cuisine. In the example, only the images generated for a single piece of the set are shown.

*Table 2. The sequence of images generated by AI: Example 2*

| Student prototype | 3 prompts | 6 prompts | 8 prompts | 11 prompts |
|---|---|---|---|---|
|  |  |  |  |  |

*Table 3. The sequence of images generated by AI. Example 3*

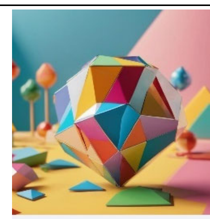
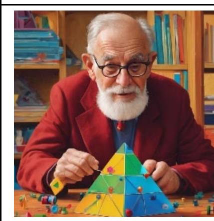
| Student prototype | 3 prompts | 6 prompts | 8 prompts | 11 prompts |
|---|---|---|---|---|
|  |  |  |  |  |

*Table 4. The sequence of images generated by AI. Example 4*

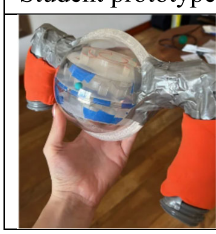
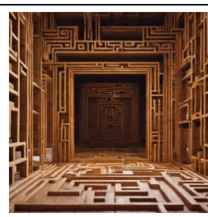
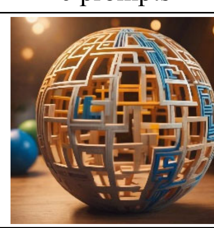
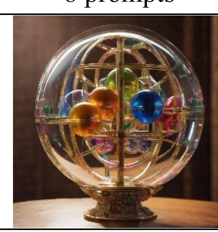
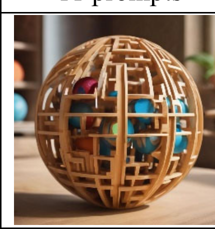
| Student prototype | 3 prompts | 6 prompts | 8 prompts | 11 prompts |
|---|---|---|---|---|
|  |  |  |  |  |

Table 3 presents another example of images generated for a playful and educational occupational therapy project for older adults. The final image shows the user interacting with the product, highlighting the intention of reflecting how the older person should use the product.

Table 4 presents the case of a product aimed at people of any age: a three-dimensional puzzle contained within a transparent sphere. The person must move so that a ball inside moves and reaches the goal. In this example, the images generated by AI largely maintain the CMFs' similarity in most cases. Still, despite the number of prompts, a logical coherence of all the elements is not indicated.

As seen in the four examples, the diversity of images generated does not necessarily correspond in principle (three prompts) with the base product. However, the exercise's idea was to use the tool to define the CMFs and not perform the product configuration in general. It can also be noted that the number of prompts increasingly impacts the similarity of the images to the initial proposed prototype.

### 3.2 About the survey applied to the students

As mentioned above, an online survey was administered to the students at the end of the exercise. The survey contained dichotomous, Likert-scale, multiple-choice questions [19], and the students responded to questions about different aspects of using the AI tool. The 22 students answering the survey consisted of seven men and 15 women.

When asked about previously using AI tools, 92% said they had used some tools, and 8% said they had no experience. When asked if they had used any tool within a design process, 54% said they had used it previously in another project.

The students were asked when they considered it best to use this tool. 75% said it seemed best in the concept generation stage (stage 3). When asked (using a Likert scale where one represents “not at all” and five means “a lot”) how much they considered that this was the best time within the design process to use the tool (stage 4 of evaluation, refinement, and production) and how much they could contribute at that stage, the result was precisely the same for both questions (see Figure 1). The highest number of students (30%) scored it as three, 24% as four, and 23% as five.

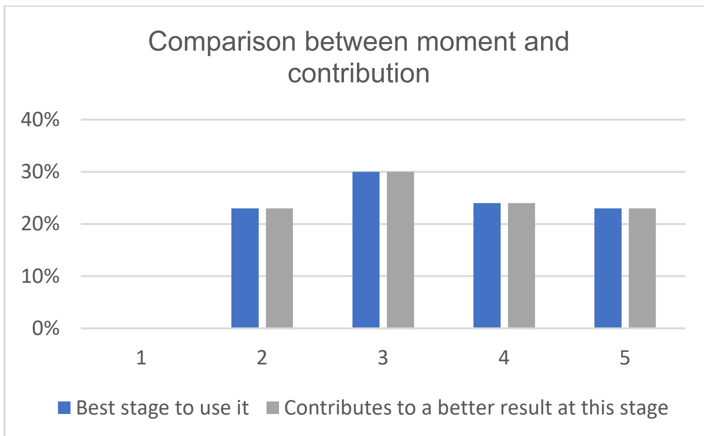



*Figure 1. Comparison between moment and contribution*

The students rated finding value in the tool to define the CMFs highly (according to the Likert scale where zero is nothing and five is a lot) in the three main elements (colours, materials, and finishes), appreciating the colour, where more than 60% rated it three or four, and the finishes, where more than 50% scored it between four and five; however, the materials also had a favourable rating although not as high as the other two elements, (see Figure 2).

Figure 3 shows the student’s assessment of the tool's value to generate new ideas and more innovative proposals; in both cases, the evaluation is quite positive (according to the Likert scale where zero is nothing and five is a lot). This corresponds to those expressed previously when 75% said they thought it was better for conceptualizing. Among other things, students were asked if they would use the tool again, to which 54% answered yes. Finally, they were asked to rate the coherence of the images generated with the proposals they already had using a Likert scale (where one represents no coherence and five indicates a lot). Forty-six percent rated it two, and 38 % rated it three; this is considered a negative assessment of the tool regarding image coherence.

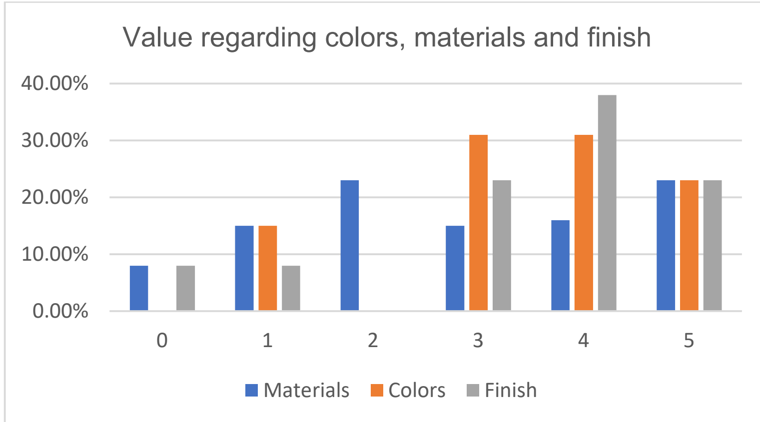



*Figure 2. Comparison of value that students give to the tool to define CMFs*

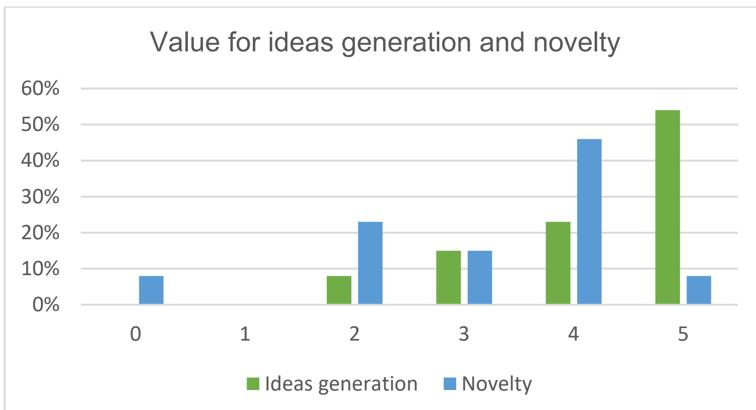



*Figure 3. Comparison of the value students assigned to the tool's ability to generate ideas and increase novelty*

## 4 DISCUSSION AND CONCLUSIONS

With the analysis of the information, it can be concluded that most students agree that the tool used can be valuable in the conceptualization or ideation stage because the images generated look like product renders produced from different ways of interpreting textual prompts. Concerning the CMFs, the majority agreed that the main contribution was the colour part, and they scored the material part slightly less. The students also stated that despite the number of prompts they provided to the tool, there was very little coincidence with the design they had already defined for the final configuration; however, despite the negative evaluation, it does not mean that the tool did not fulfil the purpose in the exercise because the objective was the CMFs, without ruling out that a learning curve could be noticed in text-to-image communication [3] to the extent that students achieve a better combination of words (prompts ) so that the tool generates what they expect, that is, an image of their product. Part of this can be considered one of the challenges that AI technology still faces, as suggested by Michelle-Villarreal et al. [4]. On the other hand, in the design process, it is evident that AI tools will impact not only the generation of ideas or CMFs, as demonstrated in this research, but that they will be linked to all the stages that arise (Hanington and Martin) [13], even to define the process itself, ceasing to be just another tool or method.

Finally, with this research, it was possible to identify that the artificial intelligence tool used is considered positively by students within their learning process and as a helpful element within product design. Likewise, it is expected that the experience with this AI tool will allow students to deepen their knowledge about the technology and leverage its potential to execute the design process more efficiently, aligning with what was stated by Huang et al. [9] about the change in design teaching based on the three "horizons." On the other hand, this research continues with different groups of students. It is expected to assess an increase in knowledge of AI as the technology deepens its penetration.

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