TRANSFORMATIVE LEARNING IN PRODUCT DESIGN WORKSHOPS: A GENERATIVE AI ASSISTANT APPROACH

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ABSTRACT
Product design workshops represent environments where technological progress has had a significant impact, especially in prototype creation processes, encompassing both the technology employed in construction and integrated components. However, project management activities persist in being conventionally addressed, susceptible to increasing the margin of error in product manufacturing and extending the time required to conclude the planning phase.
This paper delves into the initial integration of a generative artificial intelligence assistant in the search for relevant information for the execution of product design projects in manufacturing workshop environments. The advanced capabilities of generative data processing are harnessed with the aspiration that this assistant becomes a dynamic collaborator, efficiently supporting and guiding the student throughout the prototype creation process.
This research is a pilot conducted with a limited group of Product Design students, which represents a small subset of the total population of the school. The aim of this study is to gather the overall perception of students to enhance their experience when seeking information.

Keywords: AI assistant, product design education, design workshops, educational innovation, higher education

1 INTRODUCTION
Since its inception, Industrial Design has integrated technological advancement as one of its elements, allowing the design process to become increasingly efficient in product development. Recent technologies are often integrated into manufacturing, as it is common for new materials and methods of transforming them into products to emerge in production processes. However, the rest of the stages of the creative process have undergone a transformation in their practice thanks to the constant emergence of new tools and applications that facilitate and expand the potential, making the designer's exercise more efficient.
With the recent popularity of Artificial Intelligence, this is favourably seen as a watershed moment in the discipline, opening new possibilities, despite the reluctance that still exists regarding the ethical risks associated with the misuse of this technology.
It will be interesting to see how the new generations of designers will use these new tools in a way that allows them to work more efficiently without sacrificing the creative proposal or the process of conceptualising the products they will be generating. At the same time, educators should understand that these new tools do not jeopardise the creative integrity that the designer uses when developing product proposals; on the contrary, they should learn to use this pedagogically to provide their students with a methodology to expand the possibilities for the stylistic generation of their design proposals.

1.1 Artificial Intelligence
A remarkably simple definition of Artificial Intelligence (AI) is the science of having machines perform human tasks and dates to the 1950s, when scientists began to question whether computers could solve problems on their own [1]. Since then, and along with advances in computing, AI has been present increasingly closer to people. In the last three decades, smartphones, virtual assistants like Siri, smart

speakers like Alexa, and chatbots emerged, just to name a few examples. AI, for several years, has impacted production processes of distinct kinds, including (of course) education [2], [3].
Generative AI has a very promising future to enhance education, but collaboration between educators, policymakers and AI developers is important to ensure ethical and equitable considerations of generative AI in educational environments [4].

1.2 Generative AI Assistant

A generative artificial intelligence assistant (GAIA) is a model trained to assist users through an interface that simulates human interaction, using information contained in a database. Its intention is to learn from such interaction and collect data and learning models through human feedback.
GAIA can learn to provide more accurate responses and avoid behaviours that could potentially be unsafe for the user [5].

1.3 DICI Workshops

The DICI Workshops (Design, Innovation and Industrial Creation) are a multifunctional space of the School of Architecture, Art and Design of the Tecnologico de Monterrey Campus Queretaro. Within its facilities of just over 1,500 m2, there are classrooms, laboratories, workshops, worktables, two painting areas and a warehouse for loan of tools and equipment. The High Technology Laboratory has rapid prototyping equipment for FDM and SLA technologies, Cricut equipment, dye sublimation equipment, a vinyl cutter, a mini thermoformer and a machining center. The workshops have machinery and equipment for the transformation of wood and its derivatives, metallic materials, and plastics (standardised presentation or recycled). There is also laser cutting equipment, a CNC router and water jet cutting equipment. The Ceramic Workshop, on its own, has lathes, a mixer, a pouring table and electric ovens. The new Object Art and Fashion Laboratory has industrial sewing machines, equipment for jewellery making and a product photography.
Under the framework of the Tec21 educational model, students learn through a self-managed learning process that allows them to progress through exercises where they solve design challenges linked to the industry [6]. Academic moments within the classroom aim to be more effective and enable students to discover much of the information they need to build a prototype directly in workshop spaces with the support of workshop technicians' experience.
In this process, it is common for some students not to obtain the required information since they need to be physically present in the DICI space to interact with the technicians, who have a defined schedule. Outside of this schedule, there is no remote technical assistance available, and if a student requires support, they will not be able to obtain it, at least not by the first source.

2 METHODOLOGIES

In a pilot study conducted with a reduced group of Product Design students, constituting a minor segment of the overall student body within the Design program, they were asked to solve two challenges. The first one using traditional means through which they obtain information while on campus. For the second challenge, they were asked to use a prototype of a GAIA called Mr. DICI, to request and find the required information.
The study involved the participation sophomore and junior Product Design students who provided valuable information for the completion of this exercise and subsequent improvements in prototype versions.
The following outlines the features of the prototype utilised by the students during the study, along with the specifics of its construction and the platforms employed.

2.1 Mr DICI Prototype

Mr. DICI (It was named using the acronym from the DICI workshops) is an artificial intelligence generative assistant based on OpenAI technology. It is programmed to provide technical support to Product Design students and offer useful information to resolve doubts during the prototype creation phase of the product design process.
This initiative is promoted by the school’s Design department with the intention of having a full-time assistant capable of providing information regarding the creation of manufacturing projects.
The premise is that having a tool that clarifies doubts about any part of the prototype fabrication process and is oriented towards focusing on information linked to the reality of the laboratories is essential.

With the advancement of AI integration in the product design process, various aspects have been revolutionised during object creation. For the purpose of this prototype, the following services were used to ensure the functionality and access of students to the assistant: OpenAI, Chipp and Notion.

OpenAI

OpenAI is one of the most influential AI technology providers, including powerful language models such as Generative Pre-trained Transformers (GPT). In the development of the Mr. DICI prototype, the utilisation of the Application Programming Interface (API) offered by OpenAI was explored to create an academic assistant designed to support Product Design students.

The capabilities of GPT models allowed Mr. DICI's design to provide consistent support for students during the information search process for their projects. The API serves as a backbone for generating responses to academic inquiries, offering guidance on various topics such as material selection, workshop tools and equipment usage, as well as information on workshop operation, its laboratories, and the personnel operating it [7].

The GAIA Mr. DICI's engineering is planned to meet all the needs that students have during the prototype creation process, providing assistance tailored to their learning. The assistant features a personality crafted to incorporate traits of friendliness, expertise, and empathy, reflecting the qualities of an experienced academic advisor who encourages students' autonomous learning and further information seeking. There is always an invitation and emphasis on ensuring that design practices are within a framework of responsibility and sustainability. The assistant advises students to consider the environmental impact of their proposals and offers suggestions to minimise carbon footprint through responsible design decisions.

These instructions were loaded from the assistant's design manager, and various files with specific information, such as databases, were uploaded.

In Figure 1 you can see the architecture of GAIA Mr. DICI and its informatic structure, with the elements considered for the prototype.

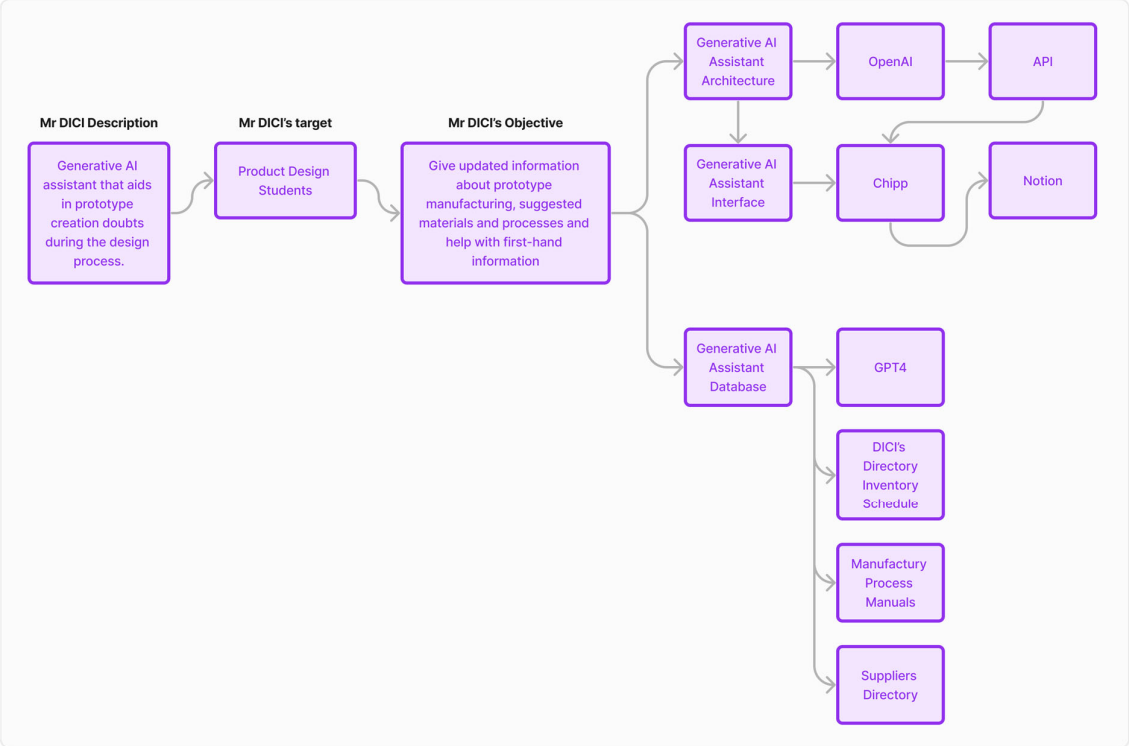

Figure 1. GAIA Mr DICI's Architecture

Chipp

To ensure students' accessibility to the assistant, Mr. DICI can be visualised on the Chipp interface through an API Key that allows integrating both platforms, enabling assistant customisation and embedding for seamless interaction.

Chipp is a platform that enables building and integrating GPTs, characterised by being fully customisable, integrated with other platforms, and monetisable. The platform does not require deep programming knowledge or code generation [8].

Notion

Additionally, the assistant is accessible through Notion, generating a microsite that provides users with a user-friendly interface within a simple platform and gives them full access to the functionalities that Mr. DICI offers.

Notion is a note-taking application that has the ability to integrate embedded applications into microsites that can be published for users to access. The platform allows for asynchronous communication with teams of indefinite size, standardising processes and collecting information, integrating external tools, and expanding information networks [9].

For the research activity, there were two challenges presented to the students for resolution. In both instances, they were allotted 15 minutes to address them.

Challenge 1

Your professors request you to develop a prototype of a shower rack that must contain containers for shampoo, conditioner, soap, fibres, and other personal hygiene utensils. The main requirement is that it be constructed with metal and wood, and you must build it entirely in the DICI.

Do not use your computer; write down your project requirements. You can refer to the DICI or your professors for information.

Challenge 2

Your professors of Modularity and Optimisation request you to develop a prototype of a desk made from standardised laminated materials that must be cut on the CNC Router of the DICI. The main requirement is that it be constructed with wood and/or its derivatives and a second material that is also laminated and cut on CNC. You must build it entirely in the DICI.

Use the Mr. DICI AI assistant to solve the challenge; assemble your project requirements on your computer.

In both challenges, it was requested to the students that they must consider the following requirements:

- Type of material according to the environment and context
- Type of joints
- Fastening
- Machinery and equipment to be used
- The person who can help you build it

3 RESULTS AND DISCUSSION

After resolving both challenges, the students were asked to answer a questionnaire containing the following questions. For some questions, the following scale was used:

- Easy
- Moderately complex
- Complex
- Very complex

At the beginning of the study, students were asked how important the use of DICI was for their professional education as Product Design students, requesting them to respond on a scale from 1 to 5, with 1 being "Not Important at All" and 5 being "Extremely Important". Unanimously, all of them answered "Extremely Important".

Despite emphasising the crucial importance of workshop usage, their perceived experience for obtaining information is considered by 22.2% as “Complex” and by 77.8% as “Moderately complex”. Below we can see the results on Figure 2.

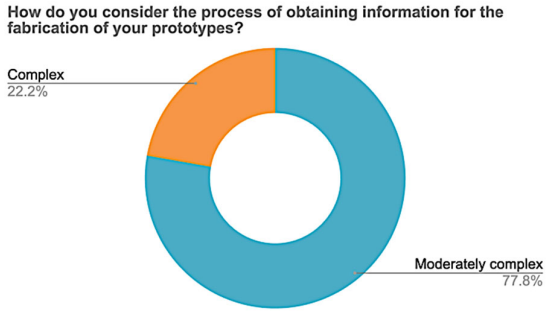

Figure 2. Student's perception during the obtaining information process before challenges

For the resolution of Challenge 1, there was a change in the perception of complexity in information searching: 33.3% considered it "Easy" as they found someone who could assist them without difficulty; 33.3% considered it "Moderately complex" as they struggled to organise themselves to find someone to consult the information, although they were ultimately able to obtain the required data. 33.3% answered "Complex" because they felt anxious about not knowing the materials required for the challenge and were unsure about manufacturing processes and joining elements to assemble the final pieces, as we can see on Figure 3.

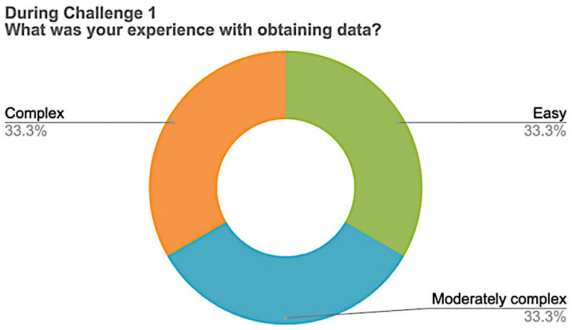

Figure 3. Student's perception during the obtaining information after Challenge 1

For Challenge 2, 88.9% of students considered that obtaining information through the GAIA Mr. DICI was "Easy" and allowed them to find the information in a simpler way than they have traditionally done. Additionally, they mentioned that having an information assistant at their fingertips gave them peace of mind. They expressed that they obtained additional information about the advantages and disadvantages of materials, as well as recommendations to improve their project. Only 11.1% of students answered that solving the challenge was "Moderately complex" because the platform failed on some occasions, the results are represented on Figure 4.

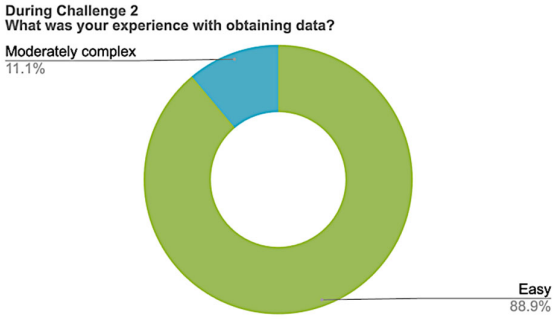

Figure 4. Student's perception during the obtaining information after Challenge 2

After completing both challenges, it can be concluded that the use of a GAIA in the product design and development process, particularly during the prototype creation phase, is of great relevance for obtaining relevant information that will allow the student to take the first step in decision-making and continue with the management and manufacturing process. Implementing this type of tools in academia will make the process more efficient and provide autonomy to students and teachers, having an ally during the teaching-learning process.

4 FUTURE WORK

With the intention of developing the generative artificial intelligence assistant, it will be applied to the Novus Fund for Educational Innovation, of the Institute for the Future of Education, of the Tecnologico de Monterrey. This fund supports the implementation of educational innovation projects that contemplate the use of new technologies. If supported by this fund, the development and implementation of this GAIA would take place during 2025.

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