Artificial Intelligence in Product Development

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Abstract

A great deal of practitioners in the product design and manufacturing area considers using artificial intelligence (AI) tools with an aim to provide u nusual ideas in a shorter period of time. The present paper is using a series of case studies in order to provide a considerable experience in using a text-based AI platform and highlight the advantages and difficulties that is needed to be overcome in the future. The new role for the AI tools within the product development cycle is stressed, while their use together with the design methodologies and the technological tools became clear. The output of these tools is mainly images that cannot be parametrically controlled and further substantial work is needed for creating the 3D models of these proposals.

Keywords
Product design; computational design; packaging design

Introduction

Artificial Intelligence (AI) has a great deal of development the last few years and its implementation is spreading to more and more applications and professions. Especially professionals in the programming computers industry are greatly affected. Education related activities have been evolved and as a results education is towards finding a new role for the use of AI (Spahiu et al, 2021b). Product development, graphical and animation applications, packaging design, corporate optical identity and product branding are some of the areas that Artificial Intelligence can play a key role, when applied, following the appropriate strategy. AI as a tool can greatly be combined with a series of methodological and technological tools used currently and thus enhance their ability to promote productivity and innovation. Additional tools such as computational design, parametric design, design automation can make use of

AI applications that can improve the time needed for product and packaging development, while improving the design engineers' capability to offer innovative solutions and proposals (Dobras et al, 2021; Manavis et al, 2022c; Malea et al, 2020). The main direction proposed is to use all the AI tools together with the process design and the design thinking approach. The term design process implies that there is a series of steps (determine objectives and constrains, prototyping, testing, evaluation etc) that the design engineers follow, with an aim to find a solution to a problem, that is set from the user (in this case the product is at the center of interest). As far as it concerns the design thinking methodology, the team of experts participating follow a non-linear and iterative approach in order to understand the users. They challenge the assumptions, redefine problems, create innovative solutions that are prototyped and

tested. In this case, the problems with difficult or incomplete definition are selected and in the center of interest is the experience created, when using a product. When these methodologies are applied, the use of words and images play a key role in the creativity development procedure and the AI tools can greatly affect and support this role (Manavis et al, 2023). At the same time, digital manufacturing and Industry 4.0 applications are supported and are made a lot more efficient. Computer Aided Design (CAD) based applications that deal with the creation of automatic product design, aim to support the new role of the design engineers and help the users to get customized products by participating in the design process. Digital optimization of geometries among a great deal of proposals under the same family of forms can increase drastically the customer satisfaction when it is used (Kyratsis et al, 2021; Spahiu et al, 2021a).

Branding and brand identity building is greatly supported by images and text. These are the main characteristics used in AI platforms, where the design engineer inserts words or complete paragraphs and the outcome is images. These images can be used for increased inspiration within the methodological tools used. For example, when a mind-map is built the images produced from an AI platform can offer a great deal of pieces of information and characteristics. Additionally, a mood-board can be far more impressive and effective, when images from an AI platform is used. The same is true in a variety of other tools and creative exercises that design engineers follow for increased inspiration (Manavis et al, 2022a). The creativity tools offer a great deal of flexibility to design engineers and out of a large number, that constitute a toolkit, the appropriate tool can be selected. They use a variety of inputs for collecting effective and high value outputs. For gathering inspiration, text can be used as input, for the Play+Make category images are used, for generating ideas the sketches provide a solid ground for visualize the proposed ideas and for building prototypes a number of different materials are used. Figure 1 provides an overview of the toolkit proposed for applying both the design process and design thinking methodologies during product design (Manavis et al, 2022b). The present paper aims in discussing the new role of the design engineer that needs to incorporate effectively the newly provided tools that are based on AI with the creativity toolkit offered for both the design process and the design thinking methodologies. At the same time, some case studies will be presented in order to discuss the opportunities opened in the future and answer the question "What is the role of AI when applied as a creativity tool?".
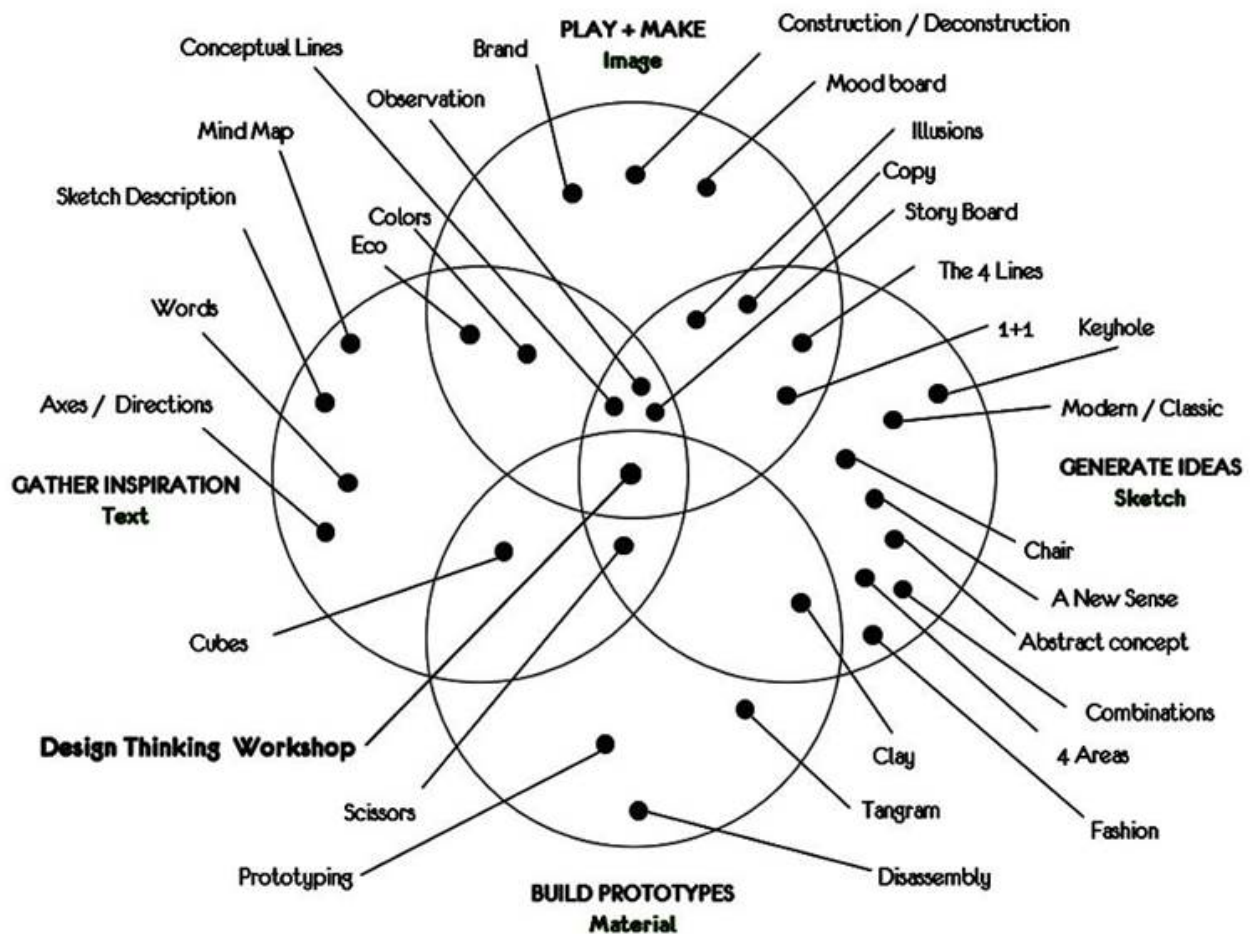

Figure 1. Creativity toolkit used by the design engineers

Methodology proposed and case studies

The main question when AI platforms are to be used is: do we need the information-based tools (like AI based tools), or the inspiration-based tools, i.e., methodological tools with the participation of the design engineer?

The role that the AI can play in the product development can lead to different directions:
- find novel ideas and provide alternative sources of inspiration,
- create new geometrical forms for products that are more likely to be innovative and successful in the market,
- produce more reliable and robust products that are less likely to fail when sold, and
- optimize the final versions of the products based on certain criteria that are relevant in each case.

This is the way to answer that in this newly formed digital age in product design, the information should be combined with the inspiration. The designer with the AI technology should work together in a supplemental way and produce far more improved solutions and products to the users, thus increasing their perception for the experience offered. The www.midjourney.com platform was used, under a payable subscription for creating a series of case studies, that can depict how the tool works and offers unusual images for inspiration purposes. This tool is an AI platform that can generate images based on text input. When feeding the AI platform with a set of words, images are the set received. The design engineer is able to refine the ideas generated from the images and receive an alternative proposal that is based on the design direction selected, keeping in mind the initial text included. This process can continue with an aim to improve the designs.

Case study in finding sketches and forms

The text used included: product design, sketch, biomimicry, morphology. The results were depicted in figure 2. The top left set of four images was the first output based on the text included and the top right set of images was the result after the refine procedure requested. The bottom image was the one selected based on the design engineer's opinion to be used further with the rest of the methodological tools provided.
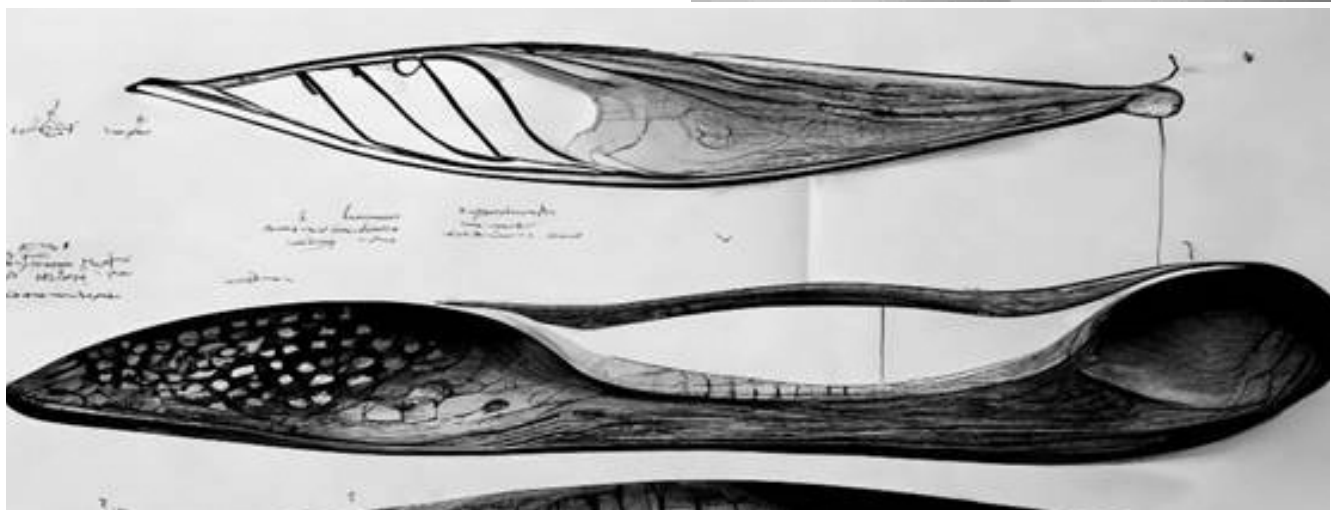

Figure 2: Results from the AI tool when specific text was used (product design, sketch, biomimicry, morphology)

Case study in product design

In this case study, the text used included: chair, leaves, veins, bending, pattern. The results were depicted in figure 3. The top left set of four images was the one that provided the directions that the design engineer can follow.

Then the top right set of images was the result of the refinement process. At the end, the proposed form to be used with the rest of the design methodological tool is depicted.

Figure 3: Results from the AI tool when specific text was used (chair, leaves, veins, bending, pattern)

Case study in packaging design (structure)

The packaging industry is one of the most creative industries and results in packages that ensure that the customer will select the product from the selves. It must attract or make an impact when the customer sees a specific product among a great deal of others that are nearby. It is a very competitive market so more design and inspiration tools are used. The AI platform was used with another set of text: product design, packaging, biomimicry, morphology. The result is depicted in figure 4. Again, a set of very impressive images were presented. Some of them stressed the idea of incorporating the principles of structural design for these proposals (left hand side) and some were more into the graphics design direction (right hand side). Further refinement could lead to more proposals based on the direction that the design engineer needed to satisfy the user demands and needs.

Case study in packaging design (shape)

In an effort to find new ideas for bottle-based packaging design, a new set of text was used: product design, packaging, bottle, biomimicry, veins. In this case again, some proposed ideas were based on the graphics design point of view (left hand side) and the rest fit better towards the structural design of bottles with improved and unusual geometries (right hand side). Further refinement can be used in order to provide more alternatives in both the directions i.e., graphics and structural. The images produced should later be transferred to 3D CAD models. This is something that the proposed AI platform did not provide this capability at present.

Figure 4: Result from the AI tool with the following text: product design, packaging, bottle, biomimicry, veins

The images produced can be used as a source of inspiration or guidance when methodological tools are used i.e., mind-map, mood-board, CAD-based sketching, storyboard, vector-based design, computational product design, topology optimization techniques, parametric design. Another difficulty encountered was the fact that for the same text input, different outputs was received every time. This can be an opportunity for more inspiration but at the same time proves, that the design engineer cannot control parametrically the output received. Reproduction of the steps followed can take place and this is something that creates additional difficulties in the product development cycle. Finally, it is the authors opinion that the new role for these AI-based tools is to be used together with the toolkits provided by the design methodologies and the other design/manufacturing technologies. They can be supportive to the mainstream product development roadmap and increase the efficiency of discovering new product development design directions.

As a future work proposal, more case studies should be developed and being assessed because researchers and design engineers should get more experience in how to combine the use of AI-based tools, design methodologies and design technologies.

Figure 4: Result from the AI tool with the following text: product design, packaging, bottle, biomimicry, veins

Conclusions

The new role that AI has to play, when product and packaging design is of interest was covered in the present paper. Extensive use of case studies provided a significant experience of the input and output taken, when an AI platform was used. The refinement capability of the different images produced offered more options and details for innovation and effective design.

Unusual geometries were depicted in 2D and unfortunately 3D models were not received from the tool. This means that an extra effort from the design engineer was needed to model these complex geometrical forms.

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