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Open AI in the Design Process

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Abstract: The laborious creation of digital images could soon be a thing of the past. Text-to-image software generates images from text descriptions through artificial intelligence, the AI can map entirely new concepts and create images in a variety of artistic styles. Existing text-to-image software is already publicly available, but does it live up to its promise, and can it be more useful to architects in their search for inspiration than previous software that uses visual search to display images? In this paper, we address the opportunities and problems of text-to-image software. To answer our question, we use a key study, this is divided into two user groups. The subjects of group A are to use DALL·E 2 to search for inspiration for a design whose task is: Design a museum with a boat dock. The same design task is also given to the subjects of group B, with the difference that they are to use Pinterest to find inspiration. We will then contrast the results of these surveys. We will document the differences of the user experience and the output of DALL·E 2 to Pinterest as well as about advantages and disadvantages of DALL·E 2 and possible future developments, and application areas of text-to-image software.

Key words: Text-to-image, DALL·E 2, Pinterest, early design process, picture generating, inspirational searching, AI.

1. Introduction

The constant development of technology has also changed the teaching of architecture. What was drawn on paper a few years ago — whether the most elaborate construction details or entire designs now takes place in computational tools. Gathering inspiration has also changed. Today's generation of architecture students is relying less and less on newspapers or books. It is one of the most widely used source of inspiration these days is social media. Pinterest is well suited for collecting inspiration. Using pinboards, any images or videos can be sorted into categories and held on to. In addition to architecture posts, Pinterest is also used to share posts about animals, tattoos, art of all kinds, beauty and much more [1].

These and other applications of this kind entice users to stay for a long time, especially due to their sophisticated algorithms. These show the user an almost endless sequence of image-related or content-related posts. Especially in the context of architecture, image-based search can be optimally used to sift through similar design ideas. A relatively new application on the market is DALL Ɛ 2, dated January 2022. Its predecessors, DALL Ɛ and DALL Ɛ mini, were introduced in January 2021. DALL Ɛ 2 uses an improved model architecture and has been trained with improved methods, making it significantly more powerful. DALL-E mini can only access smaller datasets but is an efficient tool for generating fewer complex scenarios such as logos or simple graphics [2]. Midjourney offers similar possibilities, but it cannot keep up with the user-friendly and clear user interface of DALL-E 2 [3].

Because of this we will focus on the output generated by DALL Ɛ 2 for the design task “Design a museum with a boat dock”. This specific question is well-suited for both DALL Ɛ 2 because it combines two different components that usually do not belong together, the museum and the boat dock. The developers of DALL Ɛ 2 describe that the software is particularly suited to these very combinations. “DALL Ɛ 2 can create original, realistic images and art from a text description. It can combine concepts, attributes, and styles.” In addition, this task is well-suited for Pinterest, since a lot of architectural content can be found here.

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While developing the components, we quickly came to the conclusion that it should be about the design of a museum. Museum construction is a complex, desirable and prestigious job for architects, where there are no limits to creativity. This is due to the fact that museum buildings usually have sufficient financial resources, as they often serve as the flagship of a city. This design task is fiercely contested in competitions by successful architectural firms. Numerous museums have been designed by Pritzker Prize winners and renowned architectural firms.

As a second component, we added the boat dock. This allows conclusions to be drawn about water in the surrounding area. Moreover, a boat dock is located in the outdoor space, so the design brief aimed at inspiration in the outdoor space with integration into the surroundings.

The purpose is to investigate whether text-to- image software could take on a more significant role in the architectural design process in the future. The key study is based on the assessment of architecture students who can most realistically assess whether they themselves, or someone in their industry, would use the software.

Already in the transition from analog design and work to digital processes and CAD programs, design processes and the culture of design education have changed [4]. The supposedly infinite variables and forms of editing can enhance the design process for aspiring architects and help them achieve new possibilities early on. Technological advancement has always changed design; artificial intelligence will provide a renewed impetus for change.

Since as early as the 1940s, there have been various attempts to provide design models through mathematical models and algorithms. Artificial intelligence provides a paradigm for the exploration and development of design processes, and in doing so also brings problems [5].

With this in mind, John S. Gero formulated “ten problems for ai in Design”, which can be partially refuted today. He describes mostly technical problems of coding and decoding, as well as the lack of databases from which these systems must be fed. In addition, he assumes a design process, which is to be taken over in the whole by artificial intelligence.

AI's do not exhibit any general understanding of concepts, as they lack fundamental knowledge of the physical world and objects [6]. However, despite the limitations mentioned, there is ongoing progress in the field of artificial intelligence (AI) that aims to overcome these challenges.

But the aim for now can be to create AI-based design assistants that can offer valuable insights, automate repetitive tasks, and enhance the overall design process. [7].

Taking that into account, depending on their complexity and field of application, AIs are able to recognize patterns in data such as images, texts or sounds, and to analyze them. At the same time, AI can learn from its experience to improve its performance. In addition, text-to-image software, such as DALL Ɛ 2 was trained with data from various image databases such as ImageNet or COCO, as well as text databases such as Wikipedia. To generate an image from a given description, DALL Ɛ 2 does not perform a direct database query. New images are generated using the skills learned in the training [2].

The question of how far text-to-image software can support prospective architects in the early design process arises from the following elaboration.

2. Methody

Since DALL Ɛ 2 requires registration and to simplify the use of the software, a controlled study was conducted. Furthermore, it was advantageous for the evaluation to be in direct exchange with the test persons during the use of DALL Ɛ 2.

The inductive results of the conducted survey with random focus interviews are summarized statistically, as well as in words by us. In doing so, the survey evaluations and results of the focus conversations are treated equally.

In order to produce a picture as balanced as possible, 96 students were selected for the controlled study, half of whom are studying architecture in the Bachelor's program and the other half are studying architecture in the Master's program. All subjects were studying at university's in North Rhine-Westphalia or Rhineland-Palatinate. First, the subjects were asked whether they had ever heard of text-to-image software; if this question was answered in the affirmative, they were then asked whether they had already used such software. It was also asked where the participants had heard of text- to-image software. We then divided the students equally into two user groups.

Students in group A were assigned to DALL Ɛ 2 and students in group B were assigned to Pinterest. They were then given the task of imagining a museum with a boat dock and visualizing this imagination through descriptive words using DALL Ɛ 2 and formulating it themselves in a full sentence or even bullet points (see appendix 1). DALL Ɛ 2 generates four similar images for each query. The generated results of both groups were rated according to satisfaction, suggestions for improvement or other comments were written down and it was indicated whether the respondent would use text-to-image software again.

Group B's survey and experimental procedure was similar with respect to Pinterest, where the same design task was given. Since the majority of the students already worked with Pinterest and do so regularly, no approach was given here. Since Pinterest works with an algorithm that always suggests more inspirations based on pins the user has already saved, we gave a new user account and added any selected representation of the respondents.

Group B was provided with a pinboard, to which they added their own pins. They were able to decide for themselves whether to use this foundation or to start fresh with a word search themselves.

Random focus interviews were also conducted while the experiment was still in progress in order to capture user experiences and thoughts in personal conversation. The interviews were conducted in the relevant universities, as well as online via the platform Zoom. For the face-to-face interviews, we decided in advance on topics such as the comprehensibility of the handling and follow-up questions about the overall experience to get into a direct conversation about the process and its results.

3. Results

It was noticeable in the survey evaluation that 30% more Master's students have already used text-to-image software. This can be attributed to the higher standards in the Master's program, while more basic knowledge is taught in the bachelor's program. In the Master's program, more attention is paid to the world of architecture and its innovations. 60% of the respondents have already tried text-to-image software, for the other 40% this survey is considered their first use of the software.

92% of respondents have heard of text-to-image software. Of those, 44% have heard about it through social media, and another 22% have heard about it through word of mouth from friends. The remaining 33% are evenly split between other media, the professional world, and other categories (Fig. 1). Architecture students are shown posts by algorithms on social media such as Instagram and TikTok according to their interests. This survey result provides insight into how posts about architecture and text-to-image programs are linked in these platforms.

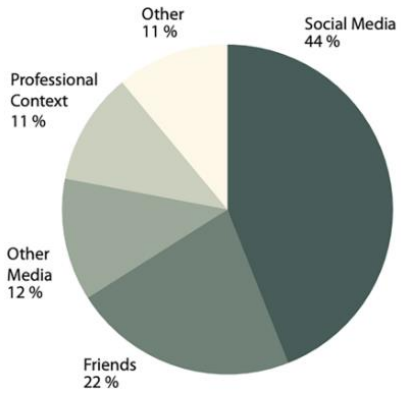


Fig. 1 Evaluation diagram where did you hear from text-to-image-software?

However, no conclusions can be drawn about the general presence of text-to-image software on social media.

Word of mouth also contributes to the awareness of text-to-image programs. Since architecture students work a lot in teams, they are in frequent and long lasting contact with their fellow students, which leads to a lively exchange. Particularly popular topics are any tools and programs in the development process and the subsequent presentation.

For the evaluation of the text-to-image software DALL Ɛ 2 and Pinterest, the students had the choices “Very Poor”, “Poor”, “Fair”, “Good”, “Very Good” and “Excellent”. 15% of Group A rated their experience with DALL Ɛ 2 as “Very Poor”, while no respondent in Group B rated Pinterest as “Very Poor” (Fig. 2). None of the respondents found Pinterest to be “Poor”, while 13% found DALL Ɛ 2 to be “Poor”. 21% of DALL Ɛ 2 subjects and 15% of Pinterest subjects rated their experience as “Fair”. DALL Ɛ 2 achieved a 4% score on the “Good” rating, while Pinterest achieved a 35% score. The upward trend continued for Pinterest with a 46% share rating “Very Good”. DALL Ɛ 2 achieved a percentage of 44%, almost on par with Pinterest. Both applications scored a 4% percentage at the “Excellent” rating (Fig. 3).

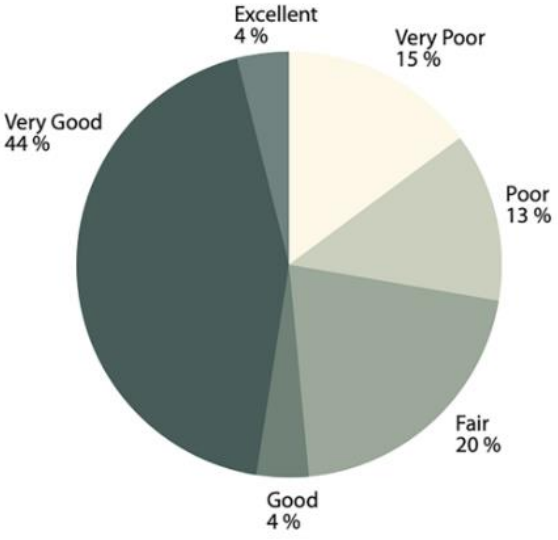


Fig. 2 Evaluation diagram group A-DALL-E2.

Fig. 3 Evaluation Diagram Group B-Pinterest.

The upward and downward spikes in ratings evident in the survey results stem from the varying demands that subjects exposed DALL Ɛ 2 to. Thus DALL Ɛ 2 has hardly or not at all considered requests to show different attributes in addition (see Fig. 4; number 10 “canoeists in the lake, people on jetty”, 14 “in carnival time”, 16, “people, planted facade elements”, 19 “museum” etc.). For queries with few attributes, DALL Ɛ 2 produced complex images despite the low input, these surprised the subject, so he rated the result much better (see Fig. 4, number 21 to 31).

First, the subjects were asked whether they considered the respective application useful in the design process of architecture. 86% agreed with this statement with respect to DALL Ɛ 2, while a full 90% did so with respect to Pinterest. They were then asked if they would use the application in the architecture design process in the future. 79% of DALL Ɛ 2 users answered in the affirmative, compared to 88% of Pinterest users.

Overall, the survey results show that Pinterest generated higher satisfaction among subjects compared to DALL Ɛ 2. Pinterest scored higher in all categories, especially in the “Good” and “Very Good” categories. However, most students found both applications useful in the architectural design process and would continue to use them in the future.


21.


22.


23.

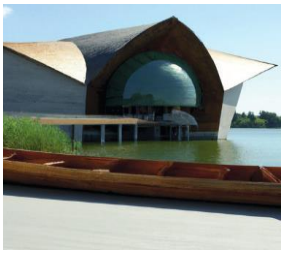

24.


25.


26.


10.


14.


16.


19.

Fig. 4 Picture number 10, 14, 16, 21, 22, 23, 24, 25, 26; Group A - DALL Ɛ 3.

The output of DALL Ɛ 2 is generated by entering sentences or words, through the design task “Design a museum with a boat dock” most of the texts entered by the subjects contain the words: “museum”, “boat dock”, “water” or even “boat”. In addition, the 1subjects indicated various other attributes, including the style that the building should emulate a particular architect, the shape and story of the building, the materials of the building, the location, certain features in the surrounding area, or even the era of architectural style that the building should have the appearance of. All the words entered were completely optional to the subjects in order not to put any restrictions on creativity (see Fig. 4).

It is noticeable in the images generated by group A that DALL Ɛ 2 always depicts a hyperrealistic building including its surroundings. The building is often cut off to a large extent from the image detail. The resulting images show neither people nor objects, and there is almost never any light burning inside the buildings. Compared to DALL Ɛ 2, the Pinterest collection offers a wider range of images from different perspectives, including models and concept sketches, covering a variety of aspects of building design. The Pinterest images feature different styles, for example, professional realistic renderings of architectural firms, photos of existing architecture, or even projects depicted in an artistic style can be found among the pins bookmarked by students. The Pinterest collection hosts more atmosphere, because here, in contrast to DALL Ɛ 2, light is often depicted inside the building also people or objects are sometimes present.

The buildings depicted by DALL Ɛ 2 are often not buildings that one would associate with a museum, despite the term “museum” being entered.

The subjects’ searches often aimed too much at an environment or objects without this having any influence on the building itself (See Fig. 5; number 9 “boat and water lilies”,15 “...with yacht”).

It is already known that DALL Ɛ 2 searches through already existing pictures on the Internet and compiles them like collages, this becomes clear with picture number 40, which has adopted the silver Gehry buildings in the Düsseldorf Media Harbor as a clear reference. In addition, another interesting aspect can be read from image number 42, here DALL Ɛ 2 has represented a jetty, although this is in the associated.

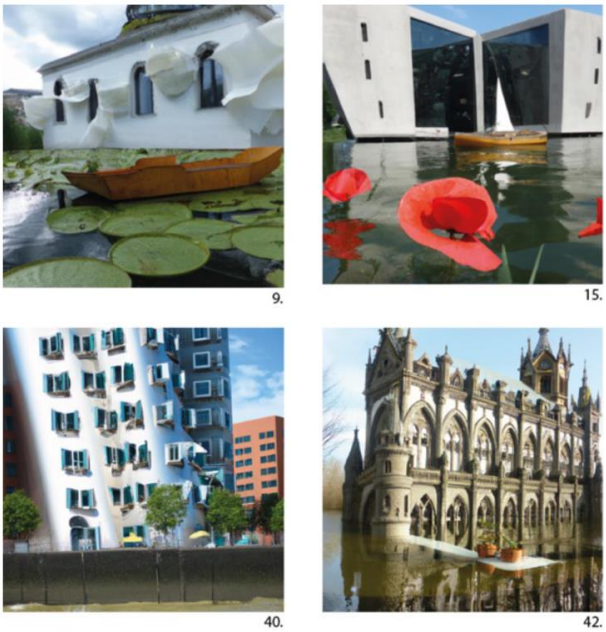


Fig. 5 Picture number 9, 15, 40, 42; Group A - DALL Ɛ 2.

4. Conclusion

From the evaluations of the architecture students, it was found that with 79% most of them would use DALL Ɛ 2 for the design process and 86% agree with the statement that DALL Ɛ 2 can serve as a useful tool in the design process. Thus, we consider the survey results successful especially due to the personal feedback and thanks expressed for showing us DALL Ɛ 2 and allowing us to try it out independently.

The partial low ratings of group A can be attributed to the fact that the software is still new and not all functions and applications are fully developed. Overall, however, the study shows the potential of text-to-image software for use in architecture and design.

Although DALL Ɛ 2 is trained to combine attributes, unlike Pinterest, Pinterest performs better due to its sheer variety and ease of searching. Pinterest offers high quality results in addition to quantity, as said pins come from renowned architecture firms or highly creatively crafted student designs.

5. Outlook

Since DALL Ɛ 2 often has difficulty including attributes in its results, the program should be trained more on this to create the best possible user experience. This includes the cold atmosphere created by the lack of light (inside buildings), people, and objects. Since Pinterest does not have these deficiencies, DALL Ɛ 2 could be trained using Pinterest images in an architectural context to improve and extend its ability to generate images. However, for initial design ideas to be collected, the lack of atmosphere hardly matters. Much more important is the information about the building contour, the use of materials, and the type, size, and distribution of openings in the building. From this, the architecture student can draw the necessary creative inspiration to expand his or her own design.

On Pinterest, one can often find the source behind a pinned image. This can be helpful, for example, in finding other projects by the same author. The source primarily gives the opportunity to learn more about the creation. This would also be of great interest for DALL Ɛ 2. Since the images generated by DALL Ɛ 2 are collaged to form a photorealistic image, the sources of the different origins could be displayed.

DALL Ɛ 2 is useful to visualize a thought from an already existing image in the mind. If subjects are placed in front of the DALL Ɛ 2 search box with only the design task “Design a museum with a boat dock”, many have trouble finding cues. This is because no picture pops into the students' heads of how they envision this design. Thus, before searching in DALL Ɛ 2, it would be useful to first search on Pinterest for inspiration and then enter DALL Ɛ 2 a combination of attributes that appealed to students on Pinterest.

Within a design, the next step after sketches and 2D drawings is to move into the three-dimensional. To do this, analog or digital working models are made. The same developer as DALL Ɛ 2, OpenAI, announced Point-E in December 2022, a software to create 3D objects using AI. Point-E creates the 3D objects using point clouds. In doing so, the program can work from text to 3D model or from image to 3D model. OpenAI also states regarding Point-E, as with DALL Ɛ 2, that the software is not yet fully mature and is therefore still

under development.

In the future, the architecture industry will increasingly rely on digital processes in the design development phase due to technological advances and the increasing digitization of designs. DALL Ɛ 2 can mature into an important tool in the design process if more students would not only learn about DALL Ɛ 2 but also try it out. In combination with Pinterest, or even after DALL Ɛ 2 has been trained with Pinterest pins, they are ideal for the early design process and gathering inspiration.

DALL Ɛ 2 is for the early design process is not yet fully developed, there are nevertheless other areas of application such as the creation of simple illustrations and graphics, as well as the creation of memes, which for the predecessor DALL Ɛ mini has led to particular notoriety through platforms such as Reddit or Twitter.

DALL Ɛ 2 has the potential to change the way we interact with visual media and how we visualize and communicate ideas and concepts.

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Appendix 1

“Museum with boat dock in the style of Le Corbusier, digital art”
“Modern museum with boat dock in the style of Le Corbusier”
“Museum that looks like a turtle”
“Museum with waterfall, enchanted, wind”
“Museum in the water by Zaha Hadid, sun, warm colors, warm day”
“Museum with multi-story boat dock in Tokyo, green roof”
“Museum with futuristic boat dock on the beach”
“Organic delicate modern museum in the water with lots of glass and people”
“Organic delicate museum in the water with boat and water lilies”
“Museum with wooden walkway on a lake, several floors and glass facade, canoeists on the lake, people on the walkway, blue sky”
“Museum on a lake, one story, wooden plank facade, walkway to the building, module”
“Museum with dock and boat dock, modern, puristic, glass, concrete, autumn, Mies van der Rohe”
“Museum in landscape, exhibitions on walkable roof”
“Winter glazed museum architecture in Venice, with boats, during carnival”
“Organic museum made of concrete in the water with yacht, poppies, 1 pm”
“Lake museum with wooden boat dock, organic shape, several floors, people, planted facade elements, sunny day”
“Modern museum near water, in the port area, parametric architecture, with visitors”
“Hybrid museum, urban area, future, 3D printed concrete, in the style of Zaha Hadid, parametric cubature”
“Museum, lake, dock, cozy, photorealistic, water, boat, bird, art, fog”
“Modern museum with organic shape, boat dock and sailboat in nature”
“Modern museum with organic shape, boat dock in nature”
“Modern museum with organic shape in the water with boat dock in nature, sunset”
“Modern museum with organic shape in the water with boat dock in nature, romantic”
“Modern museum with organic shape in the water with boat dock in nature”
“Modern museum with organic shape in the water with boat dock”
“Modern museum in the water with boat dock”
“Museum in the water with boat dock”
“Museum with boat dock”
“Boat dock with Museum of Modern Art, trees”
“Boat dock with modern museum”
“Boat dock with museum”
“Underwater building with entrance on the shore of the lake, cheerful visualization”
“Building in the shape of a tornado in the water with dock for boats”
“Snowy building by the lake with reindeer and large window facade from which people look out”
“Museum with portal to another world”
“Public building by the lake, boat rental at the corner, green space on the roof, glass façade”
“Building over the lake made of wood with small window openings and 6 floors”
“Floating building over the lake consisting of transparent asymmetrical surfaces”
“Flying building over the lake made of glass, cube”
“Building by the water, many visitors in the outdoor space, architecture very organic and utopian”
“Museum with dock into the water, boats pass through the museum, blurring of inside and outside”
“Gothic-style museum in the water”
“Museum on the lake in the style of Mies van der Rohe, summer day, cheerful atmosphere”
“Museum on the lake in the style of the Dancing House in Prague, summer time, swimming, boat dock with pier on the lake”
“Museum on the frozen lake, winter time, people ice skating, brick building with modern elements”
“Museum on a river with a pier, building cantilevered over the river, distinctive edges”
“Museum on an island in the Pacific, palm trees, beach, people”
“Minimalist museum on an island, romantic, ivy”

Appendix 2

Users Search queries; Dall-E2 (picture 1-8), Pinterest (picture 9-15)