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MODELLING INTERIOR YACHT DESIGN CONCEPTS CROSSING MULTIPLE AI TOOLS: TEACHING IN AN UNCERTAIN AND FLEXIBLE FRAMEWORK

Arianna BIONDA[1] **and Gildo INCITTI**[2]
[1]Politecnico di Milano, Italy
[2]POLO Platform, Belgium

ABSTRACT
Yacht design, a multidisciplinary field blending design, architecture, and engineering, demands coordination across the discipline's diverse competencies. The advent of Artificial Intelligence (AI) tools in design modelling and sketching is transforming the role of yacht designers, sparking debates in the professional realm. AI sketching, once an inspiration tool, is now becoming a design creator, reshaping both daily workflows and curricular training approaches.
Within the framework of the Executive Interior Yacht Design specialization course at the Politecnico di Milano, an instructional module focused on Advanced Drawing Skills was introduced to a cohort of students. It aims at equipping students with AI skills for yacht interior concepts and foster adaptability within a flexible panorama.
This paper delves into the course's pilot case, detailing intended outcomes, methods, tools, and learning exercises. Evaluation encompasses student and lecturer perspectives, collected by a dedicated interview and survey that assesses the overall learning experience. Results are presented and discussed on three levels: output image quality (content adherence, variation, style, interference), student-AI interaction, and learning environment. The study underscores the efficacy of integrating AI education in executive interior yacht design courses, providing students with tools and methodologies for concept creation. It highlights how the course shifted the learning approach from applying knowledge to experimenting with practices. In navigating the dynamic landscape of evolving generative models, the research emphasizes the importance of adaptability and resilience in preparing students for future yacht design careers amidst uncertainty and flexibility.

Keywords: Yacht design, interior design, artificial intelligence, AI teaching and learning, image generation

1 INTRODUCTION
The integration and adoption of novel technologies in the domain of teaching have undergone rapid evolution over the past three decades [1]. Considering this trajectory, it's likely that recent advancements in Artificial Intelligence (AI) and machine learning will significantly impact future labour markets, competency requirements, and pedagogical practices [2]. In navigating the complexities of epistemological and ontological dimensions of AI, this study defines AI as computer systems or intelligent agents capable of collecting, analysing, and representing data and information to achieve complex goals [3]. These intelligent capabilities may manifest in various forms, such as the ability to memorize and recall information [4], optimization and autonomy of procedures and parameters, and comprehension of human natural language [5].
While the accomplishments of AI heavily rely on data conformity, creativity often leverages human imagination to generate original ideas that may deviate from established rules. Creative professionals draw upon a lifetime of experiences to think innovatively, posing 'What if' questions challenging traditional constrained learning systems [6]. Across the expansive creative industry, AI tools start being implemented in content generation reshaping the landscape. Computational tools for sketching are emerging and continuously evolving, facilitating the generation of fresh design ideas by provoking with unconventional semantic and visual stimuli. Industry leaders like Adobe and OpenAI are at the forefront, introducing innovative tools to the brother public, eliciting mixed sentiments among designers [7].

As happened in other creative industries, yacht design is starting to be challenged by the introduction of these tools. Yacht design is a multidisciplinary sector where skills from design, architecture and engineering education are applied. The designing of yachts has evolved over many centuries and is now acknowledged as an iterative process heavily influenced by the engineering discipline, which can stifle the influences of design and creativity in the process [8]. The students involved in this field need to coordinate highly diversified areas of competence: design, architecture, ergonomics, and materials, with their respective specialised disciplinary articulations.

The rise of AI tools for design modelling and sketching rapidly evolves the role of exterior and interior yacht designers in early-stage concept creation, opening debates within the professional context. While a continuously growing number of AI yacht design concepts are posted on the web – mainly thorough Instagram social network – designers are investigating how AI will shortly impact on their future profession and relation with clients. AI text-to-image concept generation is replacing the traditional approach of tasking a design team to create images from verbal briefings. However, the ongoing debate focus on the ability to discern the viability of AI text-to-image results [9]. This perspective shift in yacht design tasks places emphasis on two key aspects of concept exploration: the precise definition of initial prompts and the evaluation of the technical feasibility of AI-generated concepts. This transition not only poses challenges to the routine tasks of designers but also necessitates a revaluation of the pedagogical approaches in higher yacht design curricula. The paradigm shift underlines the importance of equipping young designers to engage with AI technologies in a manner that extends beyond passive evaluation, requiring a proactive and informed interaction in prompt design to effectively harness the capabilities of AI in the yacht design process.

In the educational domain, the raising interest of AI is demonstrated by EU projects [2] and extensive literature reviews [10,11,12], with the number of article presenting the acronym AIED (Artificial Intelligence in Education) raised from 9 to 210 in the last ten years[1] .The main educational areas where AI applications are in place can be summarized in the following three categories [13]: Planning (receive student feedback, identify student's needs and plan activities), Implementation (give feedback, optimize activities, track progress, and managing time), and Assessment (automate evaluation, predict performance, provide personalized feedback).

Despite numerous studies demonstrating the enhanced productivity, efficiency, and quality of instructors when utilizing AIED, and the ready adoption of AI as a teaching aid, criticalities and challenges have surfaced. These challenges primarily pertain to the modifications in the learning context and the perceived social relevance of AI use in educational settings [13, 2]. The present study looks into AI as an Exploratory Learning environment and Language Learning tool [14] to investigate teaching potentialities in a continually developing design domain.

2 STRATEGIES, METHODS AND TOOLS

Within the framework of the Executive Interior Yacht Design (EIYD) specialization course at the Politecnico di Milano, an instructional online module focused on Advanced Drawing Skills was introduced to a cohort of students with architecture, product and interior design background. The module was properly designed to guide students through an educational trajectory with a twofold aim: to provide future professionals skills for mastering AI technologies for yacht interior concepts and to support the development of capabilities to adapt to - and innovate in - the flexible panorama of contemporary yacht design [15]. Throughout the module, students acquired skills in using the program's language, inserting textual prompts, blending tools, and integrating image prompts with textual and descriptive ones. The module instructs students in taking their first steps with AI, by allowing the opportunity to have a flexible design and to operate quickly, simulating the speed of changes required in the contemporary design work. Due to the instrumental nature of the teaching activity, the module was conducted in online mode.

The module initially focused on the use of Midjourney, to assist students in creating conceptual images that met the specific needs of yacht design. However, given the rapid evolution of AI tools, it was decided to introduce various instruments, allowing each student to define their own workflow as they see fit. After an initial phase of learning the program's language and basic functionalities, students experimented with inserting textual and visual prompts to guide image generation. Subsequently,

[1]data retrieved from Scopus. Research within only English languages articles; keyword: AIED or Artificial Intelligence in Education in title, keyword, or abstract. Last Access 2024, 22 February.

students were provided with specific prompts based on reference images, sketches, and existing 3D models to educate the AI to produce outputs consistent with design expectations.
Specifically, the teaching activities were divided in three steps, for a total amount of 16 hours. The first session focused on Midjourney and communication with artificial intelligence. The second session introduced LookX plugin for 3D modelling software. The final part of the course simulated a short deadline scenario where an imaginary client requested the creation of a concept for their yacht. Students had to produce four images, one exterior, and three interiors, along with a related mood board, in just three hours, integrating manual sketches, 3D models, and reference images they created. The results of teaching activity led to defining a common creative workflow, enabling the realization of designs that best meet expectations.
Qualitative and quantitative feedback from activities was sought from both lecturers and students on the following topics: (i) output image quality (content adherence, variation, style, interference), (ii) student-AI interaction, and (iii) learning environment. The results from the lecturers were obtained through semi-structured interviews, while an online survey was administered to students. The survey was divided into five parts. Firstly, participants were asked about their previous knowledge of AI tools in terms of the level of interaction and platform knowledge, rated on a scale from 1 (scarce) to 5 (very good). Sections 2, 3, and 4 inquired about AI tools in terms of student-AI interaction efficacy and openness, quality of output results, and the learning environment, respectively. Lastly, students were asked whether they used AI tools after the course and how it impacted their professional activities.
The survey was administered to participants six weeks after the end of the course while they were involved in professional activities in yacht design.

3 LEARNING EXPERIENCE OUTPUT

3.1 AI common creative workflow

One of the key objectives of the course was to provide students with a fast and flexible workflow and to verify, through the results of classroom exercises, whether such an experimental approach could still be valid. From the results obtained, it can be confirmed the following steps.
Phase 1: Sketches and Initial Design - Define the guidelines and main features of the project. Communicate the layout of spaces, colours, materials, and essential furnishing elements through a sketch, either by hand or using design software or collages.
Phase 2: Moodboard and Inspirations - Collection of inspirational images that define the style and atmosphere of the project. Use photographs, textures, fabric samples, and colours to create a collage. This can be done with graphic software, manually, or with artificial intelligence tools like Midjourney.
Phase 3: Design - Design with measurements and elaboration of initial images: Feed the AI with the first design. In this case, LookX was used as a plugin for Sketchup and Rhino, in order to obtain the first interior and exterior images.
Phase 4: Refinement - All the images are evaluated and used as input for Midjourney AI (fed with an already good idea of the final design) and refined using text and image reference prompts.
Phase 5: Correction and Repeat - As with every iterative process, the first output from Midjourney can be used as a reference for LookX, going back to phase 3 and repeating the design process.
Phase 6: Final Design - Upon completion of the iterative process, one ultimately reaches an optimal and satisfactory outcome. At this juncture, the student-designer can generate final output images to showcase their work. In our case, the ultimate tool can be Midjourney itself. However, the produced images can also serve as an excellent foundation for further refinement through post-production processes using photo editing, 2D and 3D CAD drawing programs.

3.2 The lecturer perspective

The results of the course demonstrated that the use of AI-based tools can be extremely useful in the yacht design process, specifically in the first concept generation step. From the lecturer perspective, the most interesting aspect was obtaining results that allowed defining a common creative workflow. The best results were achieved starting from base images created by students, typically simple 3D models or hand-drawn sketches. Three main characteristics describe the proposed workflow: constant iterations, adaptations and continuous refinements. It is commonly observed going back to previous phases of the process. For example, after creating the Moodboard or the renderings, some students modify the initial sketch to fit the inspirations or new ideas that emerged during the creation of the booklet. It is observed as the previously described process is fluid and iterative, allowing students to gain influences by each

phase to inspire the others. This constant evolution of concepts and ideas improved the overall quality of the project from all students.

3.2.1 Output image quality

From the teacher's perspective, the outcomes exceeded expectations. The majority of students encountered AI for the first time, particularly at a fundamental level for generating rendered images. The obtained results did not highlight these blanks, with surprisingly good results for a few hours of teaching. The quality of the obtained images was highly professional, comparable to the field state of the art. Even if some students encountered issues in setting the right prompt to assure content adherence and in managing the interference, a good level of output variation was highlighted. Furthermore, students were able to vary the style of interior design, and to instruct AI tools to meet their personal expectations.

3.2.2 Student-AI interaction

The module inspired students, engaging them in a creative workflow characterized by highly flexibility. Students reached significant levels of competence in interacting with the software, generating a variety of conceptual images reflecting their creative visions. The integration of textual and visual prompts allowed students to guide AI in producing images consistent with project objectives. Additionally, the use of prompts based on reference images and 3D models enabled students to obtain more precise and refined results, facilitating communication of their ideas to clients and other design team members.

3.2.3 Learning environment

The module's high engagement level proved effective in overcoming challenges and communication gaps inherent in the online modality. Participants' experiences in the course underscored the potential of AI tools for design education to notably augment student engagement in subsequent design stages, including the creative process, accelerated concept generation, and improved precision and coherence of outputs. Thanks to the speed afforded by AI tools, teachers have observed how students are able to push design beyond issues related to mere representation, managing to bypass that 'Lost in Translation' often caused by a lack of drawing skills or proficiency with modelling tools. This were mainly present in designers who have not yet mastered the traditional 3d modelling tools proper of yacht design. The use of AI tolls has accelerated the improvement of design skills, not only within the pilot module but also with positive outcomes across different atelier of the entire course.

3.3 The student perspective

Through a questionnaire, qualitative and quantitative feedback were gathered from students who participated in the module. Overall, the responses were largely positive, reflecting a high level of satisfaction with the learning experience.

3.3.1 Output image quality

One aspect that particularly impressed the students was their newfound ability to produce professional-quality images without the need for extensive knowledge of rendering software. The overall satisfaction with the quality of images generated by AI text-to-image tools during the course indicates a positive sentiment among the participants. Specifically, 60% of participants expressed satisfaction, with 5% reporting little satisfaction and 35% being moderately satisfied. Satisfaction levels were analysed across categories, revealing an 80% approval for content representation, a 50% moderate satisfaction with variation, a commendable 75% satisfaction with style, and a 40% satisfaction rate indicating room for improvement in managing external elements.

3.3.2 Student-AI interaction

Students were asked to assess the ease of use of AI tools in the creative workflow. Accessing and installing AI text-to-text or text-to-image tools is perceived to be relatively easy by a substantial portion of the surveyed audience, particularly those potentially lacking expertise in prompt design. Specifically, 50% find it relatively easy, 35% find it easy, and 15% find it very easy. The impression regarding the ease of use of the AI tools presented in the course indicates that 40% of respondents found it relatively easy, 30% found it easy, and 10% found it very easy. Despite that, students point out complexities associated with various aspects of interacting with AI tools, particularly in terms of precise instruction,

prompt formulation, and obtaining desired outcomes. The aspects perceived as challenging in understanding AI tools include:

- Achieving precise program output: Some respondents struggled with getting the program to generate exactly what they desired, emphasizing a difficulty in achieving specific and accurate results.
- Obtaining specific details: Participants faced challenges in instructing the AI to produce specific and precise details in its output. Moreover, removing undesired elements generated by AI, especially when the AI was not adequately trained with reference images, resulted critical.
- Understanding prompt writing for AI comprehension: There was difficulty in comprehending how to write prompts effectively to ensure clear understanding by the AI, or how to split prompts to have more accuracy.

Despite these challenges, they acknowledged the potential of AI tools like Midjourney to create inspirational mood, and LookX to address issues related to image perspective, leveraging base 3D models to enhance visualization accuracy.

3.3.3 Learning environment

The utilization of AI tools prompts learning in an educational context. According to survey responses, 70% affirmatively acknowledge that AI tools stimulate learning, while 30% indicate that such stimulation occurs only to some extent. Furthermore, the tools and methods introduced in the course were evaluated in terms of their flexibility to address a continually evolving domain such as AI. Participant responses indicate that 10% of students perceive these tools as somewhat inflexible, while the majority, comprising 80%, consider them flexible. Additionally, 10% of students express a high degree of flexibility, deeming the tools decisively flexible and suitable for the dynamic nature of the AI domain. In addition, many students expressed keen interest in delving deeper into AI applications within their future professional career. At the question “Do you believe that AI tools will impact the way you perform your profession? “survey responses indicate that 70% affirmatively anticipate a potential impact, while 30% expect only partial influence, with uncertainties on the effectiveness of these new tools. However, among those who anticipate an impact, 30% foresee a negative influence, 10% hold a neutral stance, 20% expect a positive impact, and 10% anticipate an extremely positive effect. These results indicate a recognition of the transformative potential of AI in the field and a desire to further explore its capabilities to streamline design processes and enhance creative output. Despite that, the diversity of perspectives on the yacht designer work highlights the complexity of behaviour and expectations surrounding the raising of AI tools on professional practices.

4 DISCUSSION AND FUTURE PERSPECTIVES

This study highlighted not only the potential of using AI-based tools in yacht interior and exterior design, but also demonstrated the effectiveness of such tools in facilitating the creative process and improving visual communication in the context of design education.

The integration of AI into yacht design education presents exciting opportunities for students to explore innovative design methodologies and gain practical experience in utilizing cutting-edge technologies. AI can be incorporated into university courses to provide students with tools for rapid idea generation, even for those who may not have mastered 3D modelling or rendering software. By leveraging AI-driven platforms, students can develop conceptual designs, iterate on ideas, and communicate their vision effectively, thereby preparing them for careers in the dynamic field of yacht design. Moreover, AI-based education initiatives can foster creativity [7], collaboration, and critical thinking skills, empowering the next generation of designers to push the boundaries of innovation in yacht design. In this specific industrial context, AI has emerged as a valuable resource, offering young designers new avenues for exploration and experimentation. However, limitations arise from the complexity of yacht 3D geometry, posing challenges in maintaining control and precision during the design process. While AI tools can assist in generating initial concepts and refining designs, human expertise remains essential in navigating intricate details and ensuring the feasibility and functionality of yacht designs [8].

In conclusion, the utilization of AI in the EIYD university course proved to be highly beneficial and promising. The results demonstrate a significant improvement in students' competence in interacting with AI software and generating diverse conceptual images aligned with project objectives. Feedback from students highlighted the remarkable potential of AI tools in simplifying complex design tasks and producing professional-quality outputs. Despite encountering challenges such the communication with

the AI about the desired output or eliminating unwanted AI-generated elements and defining materials, students expressed keen interest in further exploring AI applications in their future professional career. From the instructor's perspective, the outcomes were highly satisfactory, underscoring the effectiveness of the course curriculum in bridging students' knowledge gaps and fostering proficiency in AI-based design methodologies, with participants showcasing impressive results within a limited timeframe.
Although the results have been satisfactory, the rapid advancement of AI image generating tools leaves ample room for a more in-depth development of design teaching in this area [3]. From this pilot project, potentiality emerged not only for the conceptual and visualization phase but also for a critical understanding of the creative process and for accelerating the learning curve. An additional module in Advanced Drawing Skills, based on AI text-to-image tools, is now introduced to a new cohort of 30 students in yacht design. This Further experimentation aims to refine the teaching strategy to fully exploit the potential of AI tools and seamlessly integrate them into the yacht design workflow. The module is scheduled at the beginning of the master's program. In this instance, the docent immediately initiated students into the use of AI at the outset of the course, enabling students from diverse academic backgrounds to approach to AI image generation tools. This paves the way for intriguing developments in the continuation of the master's program, rely on AI tools not only for the production of final images but also as sparring idea generators in the design process itself.

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