AI-Powered Design Ideation: The integration of AI tools into the design process within the digital transformation of architecture

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In 2018, RIBA and Microsoft issued a collaborative report that reviewed the digital transformation of the British architectural industry. Among digital technologies was Artificial Intelligence (AI), with 5% of surveyed architects using it.[1] Aspiring to create better living environments, architects always adopt the newest design technologies, so now this number reached 41%.[2] AI-powered software is available in the Autodesk catalogue. World-famous firms develop in-house AI systems and participate in AI-incorporating projects (Figures 1-2).

Although AI is treated with reasonable caution and mistrust due to radically changing the status quo, RIBA believes it can provide new opportunities for innovation, automate repetitive tasks to allow focus on creativity and improve efficiency by analysing more design variations in a shorter time.[3] This article briefly introduces my colleagues to AI, explains how it is already used in architecture, and discusses whether it threatens the profession.

Architecture is a multidisciplinary industry which merges rationalism and empiricism. Rationalism focuses on mathematical, logical, and algorithmic thinking, while empiricism pays attention to context, diversity and uncertainty.[4] Likewise, a meaning behind the building design requires considering unquantifiable and subjective aspects like history, philosophy, politics, etc. However, its feasibility and successful operation rely on strict quantifiable parameters and real-world rules from mathematics, geography, or physics. This duality resulted in formulating two AI-usage approaches in architecture: optimisation (focus on quantifiable parameters) and creativity (focus on more abstract aspects). With the emergence of AI-powered tools, both methods are already used to perform architectural tasks at different design stages.

Understanding AI's nature is vital for implementation in architecture. Despite no agreed definition, AI is most characterised as a computational system which imitates human cognitive functions to achieve goals.[5] AI domain includes many types, but Machine Learning (ML) is of most significant interest to the creative sphere. ML systems are trained by observing, capturing, and approximating data characteristics and then automatically generating this data under new settings and parameters. Artificial Neural Networks (ANNs) are ML systems that imitate the human brain's operation when the data is transferred through layers of interconnected architectures (called neurons) in two directions.[6] ANNs with more than two hidden layers are called deep neural networks (DNNs) and compose the most advanced AI models, such as VAE, GAN, diffusers, and transformers. With the assistance of encoders (another type of DNN), they can be trained with text, images, 3D shapes or music and generate them.

AI entered the design ideation via generative models with a two-stage synthesis. The designer encodes the generator tool with input to produce the output and then alters the input based on feedback to obtain new output variations.[7] In architecture, generative modelling is commonly used in visual programming software like Grasshopper and Dynamo. With the invention of genetic algorithms and ML, Grasshopper and Dynamo could automatically convert numeric input parameters into multiple geometric shape variations and eliminate the least-fitting ones.[8] Image-generating DNNs are also generative models, but more complex architecture allows them to process more advanced input and output, like text or pixel images. Consequently, "generative design" is commonly associated with optimisation, while "Deep AI"

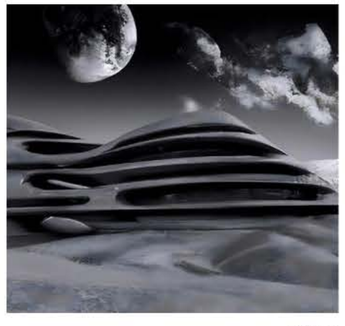

Figure 1

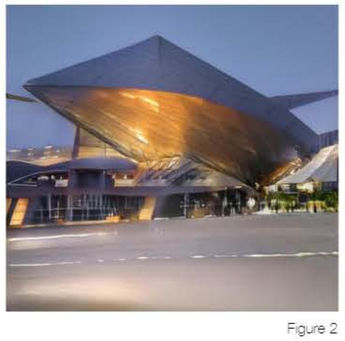

Figure 2

refers to creativity. Although such separation is simplistic, it might be more task- and output-specific. Independently, AI cannot perform creative tasks because it cannot extrapolate like humans.[9] Its training is like architectural students absorbing knowledge in university, but its generations are infinite reiterations of the dataset. AI trained only with Classic buildings will never generate a Brutalist one. However, designers can use expertise to make the generations meaningful by creatively formulating the input and interpreting the output.

My Master's dissertation investigated different methods of using AI-powered software at the early design stage. The first part translated the visual output of the Stage 5 Final Design thesis into text prompts using S. Chaillou's semantic mapping method with an eventual generation of images with four Text-To-Image models based on the prompt. The latter two were also fine-tuned with a curated dataset from my FDT work. The results demonstrated that prompt-building requires a good knowledge of architectural vocabulary to deliver the message to the machine competently. The generated images were visually evocative, but relying on computational stochasticity rather than real-world rules made them structurally incompetent or physically distorted, particularly in diagrams and orthographic drawings. However, AI's ability to mimic unique architectural features after training allowed it to transfer them onto generic sketches, 3D models, and AI-generated images. At this point, AI-powered Autodesk Forma's ability to automatically generate multiple massing iterations based on input parameters (dimensions, number of floors, typology) and complete feasibility analysis allowed me to choose the best solution and project my FDT style on it (Figure 3). With high visual abstraction, the output could be a design iteration of the FDT in a specific context. Some see this as an alternative to sketch drawings or models, as the designer may produce more variations quicker, test material textures from the beginning, and make massing iterations from accurate climatic data.

However, AI's threat to professional practice and education is severely discussed, particularly in art. AI-generated images reached state-of-the-art quality in less than a year, which worries professional artists. Developing artwork is resource-consuming, while instant generating many pictures in one click may be more tempting for potential employers.[10] Architecture is more multidisciplinary, and any AI-generated output is not a complete architectural project. It requires a designer's expertise and critical thinking to analyse the variations and choose the most appropriate ones. Nevertheless, the ethical implications arise from AI tools' "black box" nature when the user knows only input and output.[11] The accuracy of such systems (like DALL-E and Midjourney) is appealing, but concealed source code and dataset reduces assurance that the tool's decision-making wasn't tuned towards bias or that its dataset doesn't contain copyrighted work or explicit content. Human-centred AI is proposed as a primary strategy: instead of replacing humans, AI augments their design practices, making them the final decision-makers.[12] Autodesk Forma pursues this strategy via "Greyboxing." "Black box" AI components are provided as instruments in conventional 3D CAD interface, which the users may freely use to develop a design proposal based on their expertise in architecture, urban planning, and environmental design. Curated datasets are another strategy to make AI more architecture-specific, explainable and transparent. A dataset assembled by an architect for a specific task and labelled with correct architectural vocabulary would increase ANN's explainability and assist in solving the issue of bias and sensitive content.

Overall, this article is only the tip of the iceberg. Most student projects remain on paper with prevailing theory, so my Master's dissertation focused mainly on AI in the early design stages. Also, due to the topic's novelty, many written sources are yet to be published, and as AI develops further, new methods of its adoption in architecture will appear, and new implications will arise. The researchers urge us not to confront it but to use humanity's problem-solving skills to work towards efficiently and ethically integrating AI into the whole architectural supply chain.[13] After all, with the digital transformation of the creative industry, AI's introduction to it was inevitable.

Figure 3

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