ARTIFICIAL INTELLIGENCE AND THE FUTURE OF STRUCTURAL ENGINEERING

What will be the impact of artificial intelligence (AI) in 30 years' time for the built environment? Will the role of the structural engineer simply cease to exist?

In today's world, we can already prompt AI to complete a specific task using set commands and specific constraints. In the future, we believe AI will be much more personalised to the person and profession, which will allow itself to query the request to gain more context and provide more specific results beyond what is asked for.

AI will 'live' within the work, always on in the background, anticipating next steps and identifying potential issues. In addition, it will accurately predict the effect of climate change and subsequent behaviour of structures, distilling millions of data points into easily comprehensible analytics, with recommendations to achieve the desired outcomes. With AI, structures will adapt to their environments, thus increasing the robustness of the designs.

The focus of our submission centres on our work on the New Danube Bridge (NDB), a new iconic cable stayed bridge structure poised to cross the river Danube in Budapest, Hungary. We examine the life-cycle implications for this bridge imagining the application of AI tools starting from 2050.

Images generated by Midjourney

SUSTAINABILITY

AI would improve sustainability of the NDB via diverse data analysis. For instance, AI could provide recommendations to the design based on locally available materials and fabrication facilities. Additionally, AI could maintain a database of reclaimed materials from local deconstruction projects and identify elements suitable for reuse or suggest designs to suit the materials available. Finally, the power of AI would enable quicker and more detailed embodied carbon estimates at various stages and provide reduction recommendations.

BIDDING

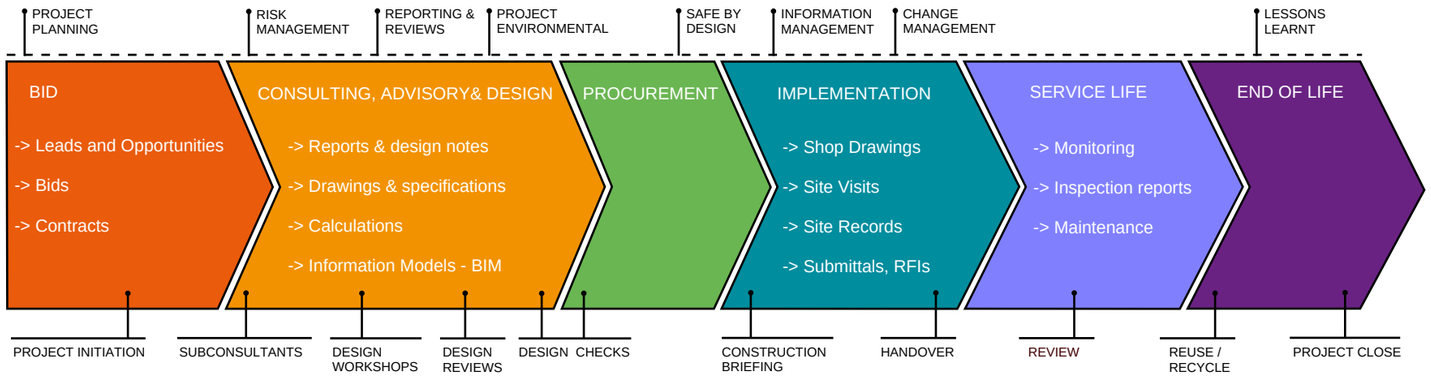
For bid opportunities such as the NDB, AI could assess projects that suit the capabilities of the team, accounting for planned resources and future workload, and provide a recommendation on whether to pursue.

LEARNING

At the start of the NDB project, AI could be used to identify relevant precedent projects, calculations and specifications, design code clauses, and the latest technical guidance documents and highlight any skills gaps that may be present. Furthermore, it could identify the differences in the Hungarian e-UT specifications to the designer's home country to develop custom learning and development sessions.

CONSTRUCTION

During NDB construction, AI could keep track of materials, fabrication processes, and progress to check construction methodologies are being followed and completed in accordance with the contract documents. AI-driven robots could undertake high-risk site activities like heavy lifting or working at height and support in the fabrication of intricate steelwork details. Changes to the construction could be automatically captured and implemented into live models using AI, and the creation of as-builts could be automated and delivered to the client.



RISK MANAGEMENT

Projects like the NDB include a broad range of risks. Internal factors such as design complications, ground conditions, material availability, along with external factors relating to political, social, and economic conditions. AI's processing capacity aligns well with computing these risks for holistically analysing them.

Insights would be collected by analysing various types of data from past projects, including time frames, spend profiles, risk registers, etc. These insights could then be automatically highlighted throughout the project life-cycle to anticipate and mitigate against potential design and construction issues early on.

DESIGN

For the NDB competition stage, AI could generate concept images with various geometries, materiality, and aesthetics for inspiration. AI could develop section sizes and costs based on rules of thumb, past precedents, and simple analysis models, allowing for the comparison of solutions in short time frames.

Software-agnostic models could be built automatically using commands and hand sketches. Further on through the design process, AI could perform complex analyses, optimisation, and generative design, providing recommendations where necessary, simplifying the design of complex elements like the pylons. Through the production process, AI would automatically detect errors, inconsistencies and clashes and provide details for comparison from past projects.

INSPECTION & MAINTAINENCE

With AI, inspections for the NDB would become more data-driven, efficient, and accurate. Automated visual inspections could be performed using drones and high-resolution images to detect and monitor defects as well as signs of deterioration. Sensors in major elements such as the stay cables could predict corrosion levels and trigger alerts for maintenance. This would help inspectors identify key elements to inspect.

AI could prioritise maintenance activities for the NDB by undertaking holistic data analysis. General maintenance such as cleaning pylons and deck surfaces, painting and weld repair would be performed with AI-driven robots.

COMMUNICATION

Being an international project, the NDB would greatly benefit from AI and integrated language tools. Document drafts such as bid forms, planning application forms, design reports, and risk registers could be automatically populated in both languages, saving time and costs on typical administration duties. Reports will be edited and summarised to better suit the reader's role. Additionally, the use of AI during in-person meetings and clarifications during the construction can ensure everyone is on the same page.

Images generated by Midjourney

RESPONSIBILITY STILL LIES WITH THE ENGINEER

We believe the jump in 2050 will mirror the transformative impact of computers, which allowed many of the complex modern structures of today to be realised. The introduction of the computer didn't eliminate the role of the structural engineer, instead it liberated them from often times complex, repetitive, and mundane tasks through the use of finite element software and computer aided design. Similarly, AI in 2050 will have the same impact and unlock more time for creativity for the engineer.

While AI will no doubt provide useful insights and tools, engineers must retain oversight, verify these insights, and use engineering judgement to make informed choices. Engineers must avoid the use of AI as a 'black box', particularly during decisions that require nuanced understanding of bridge design, construction, and maintenance.

Furthermore, we believe that that great design is built on communities and stories which develop human connections to make culture what it is. No doubt AI will maintain inherent biases from their creators, and whether it's AI generated music or architecture, local communities won't relate in the same way, therefore design should be left up to the people.