

BES502270

Using AI for Sustainable Structural Design with Daisy and Autodesk Research

Kasia Borowska
DAISY AI

Kosala Bandara
Autodesk Research

Learning Objectives

- Learn how AI can make construction design processes more efficient.
- Discover the trade-offs involved in using different materials and how this can be used to reduce environmental impact.
- Learn about validating whether AI can help structural engineers produce better designs.
- Learn about some of the trade-offs involved in collaboration between research and commercial teams.

Description

Design AI Systems (DAISY.ai) is the first timber design software powered by artificial intelligence (AI). DAISY produces optimal, code-compliant designs in less than 10 minutes, saving engineers 2-3 hours a day, and reducing up to 80% of timber waste. Kratos is an Autodesk Research project using AI methods to rapidly evaluate many structural designs in multiple materials, including concrete. Solutions can optimize for monetary cost, carbon cost, or other objectives. DAISY AI and Kratos collaborated by using Kratos to calculate load-bearing walls in a timber structure, which DAISY can use as input to produce detailed floor plans. This leads to less concrete used in foundations, hence, cheaper and more sustainable designs. Sharing of algorithms was not feasible, so a "black box" approach was taken instead with only data formats shared. The result was that in the summer of 2021, DAISY and Kratos designed a timber floor in a house that was subsequently built in the United Kingdom.

Speaker(s)

Kasia Borowska, Director DAISY AI; Managing Director, Brainpool AI



Kasia Borowska is a director at DAISY AI and co-founder and managing director at Brainpool AI, a worldwide network of 500 Artificial Intelligence experts. Having degrees in Mathematics and Cognitive Science as well as corporate experience Kasia understood how important it is to connect the two worlds and find new applications of the latest academic research to solve the most pressing business challenges. DAISY AI is one of the first products brought to live through a partnership and strong collaboration between Artificial intelligence researchers and timber construction

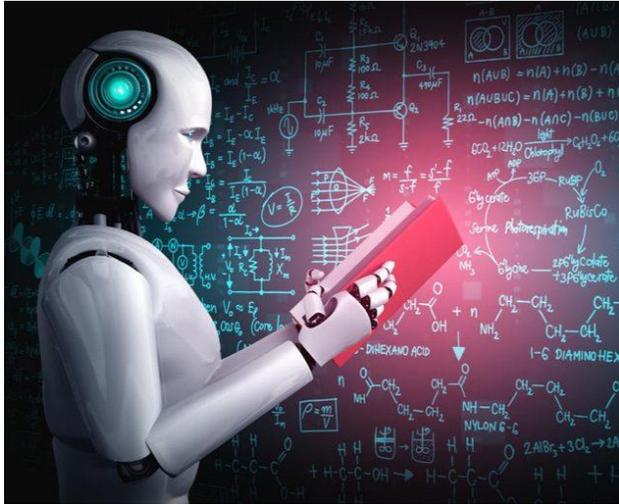
industry experts. DAISY is a fully automated timber design software, allowing engineers and architects to find the most optimal designs with a click of a button. Thanks to DAISY we can reduce timber waste, meaning that less trees will need to be cut to build our homes.

Kosala Bandara,



Kosala Bandara is a Research Scientist in Autodesk Research and is based in London. His work involves research and development into new generative design algorithms for both manufacturing and construction industries. Originally a Structural Engineer, Kosala has spent a decade advancing generative design for manufacturing. Lately, he has returned to his roots and started using generative design for Structural Engineering.

Why is applying Artificial Intelligence in Construction so difficult?



The current state of artificial intelligence research allows us to design AI systems able to provide solutions for one specific objective. The type of data that is fed into such a 'narrow AI' system determines the range of possible outputs. For example, if you try to train a machine vision system to recognise pictures of shoes, but you only feed in pictures of trainers then the system is unlikely to classify a picture of high heels as shoes.

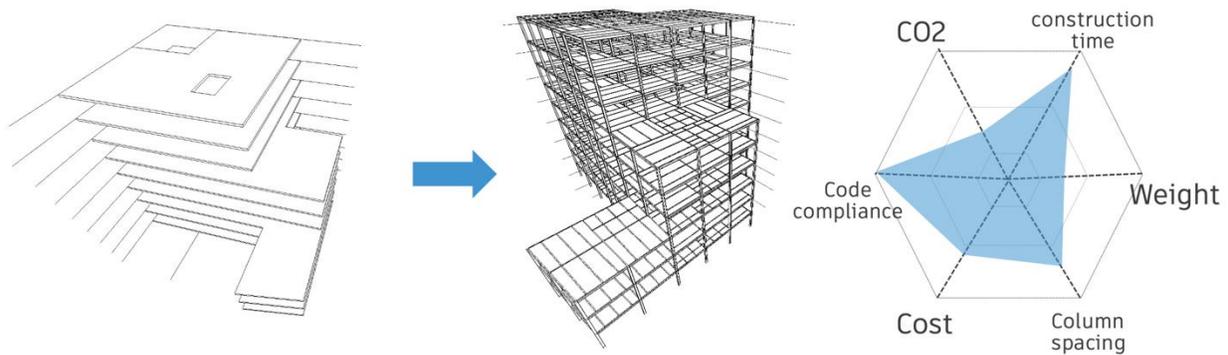
When we talk about robots taking over the world (or watch 'the Terminator'), what we typically have in mind is Artificial General Intelligence (AGI), which is capable of applying knowledge in one area to solve a problem in a

new unrelated area, increasing the scope of possible objectives that can be achieved. AGI doesn't exist yet, depending on who you ask you may hear that it will take anywhere from 38 years from now to never.

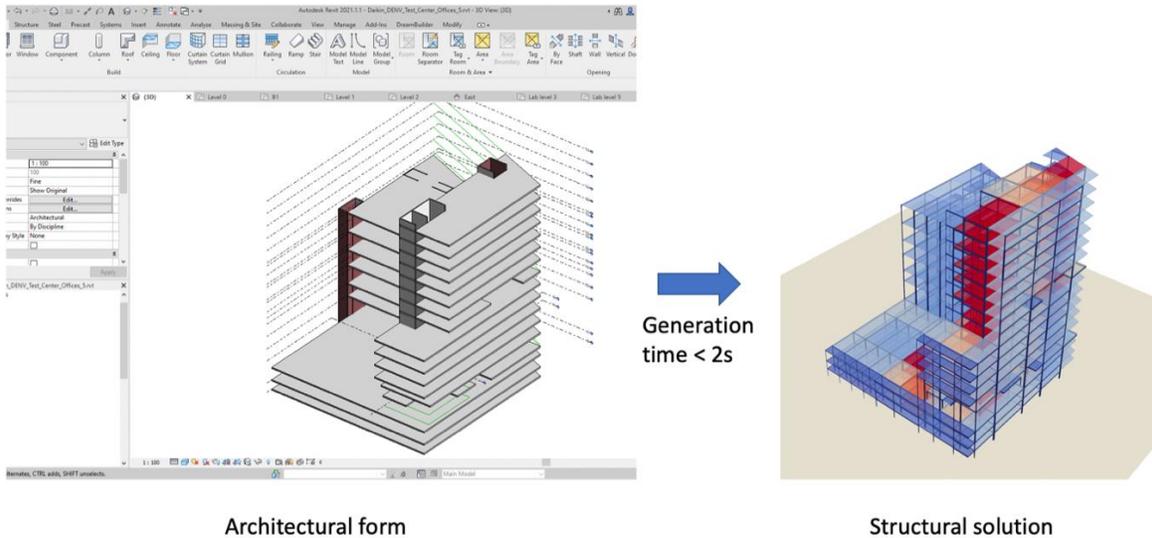
The construction industry projects typically have multiple objectives by their very nature. You want your house to be spacious, robust, ideally not too expensive but also built with a minimum possible carbon footprint. What needs to be optimised is also typically a whole range of aspects of the build, taking an example of a simple timber floor you need to take into account joists, beams, decking sheets, metalworks, stairs openings, internal walls. **We are trying to solve multiple layers of optimization with a multi-objective function, which is difficult for narrow AI.**

DAISY AI and Autodesk Research both tackled this problem for various areas of construction. Here is the outcome.

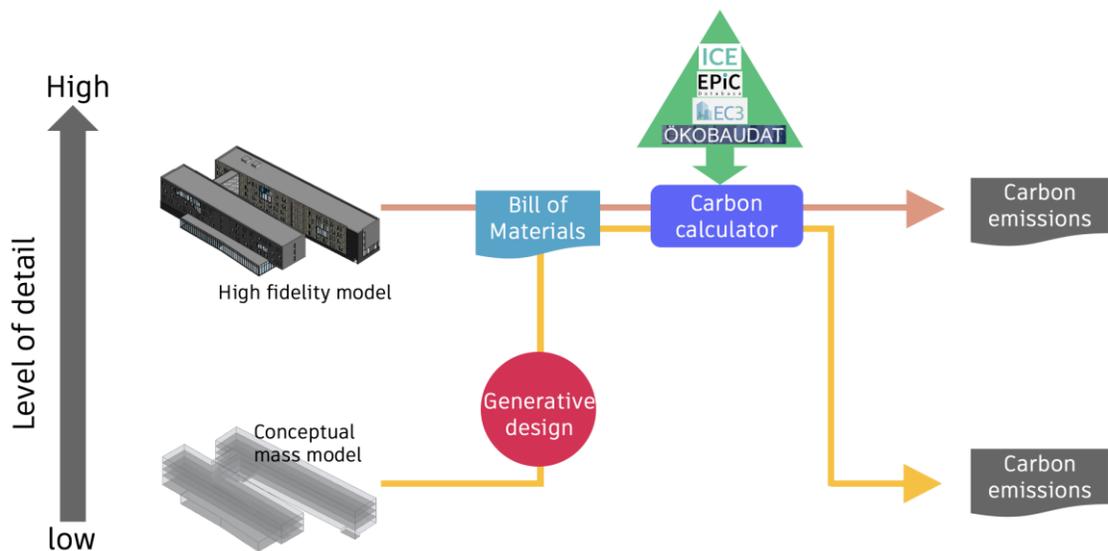
Kratos - Generative design for Structures



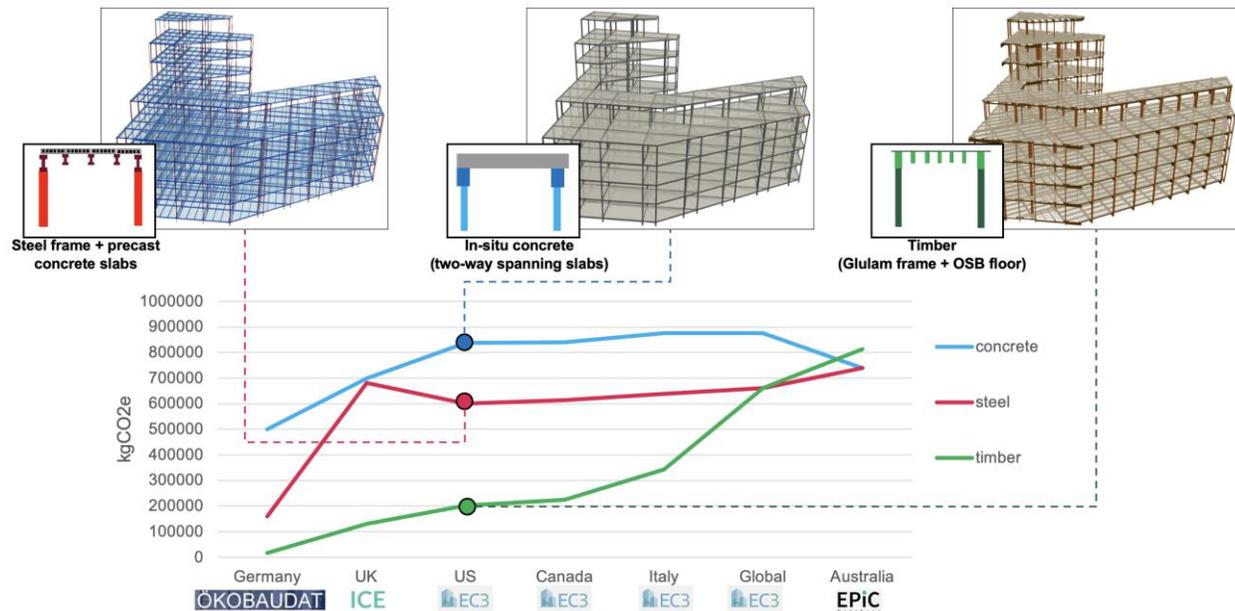
Kratos is an AI-powered generative design engine for automatically creating optimised structural systems for given architectural input, subject to design and construction constraints. This helps architects design with constructability in mind, where they can quickly evaluate the feasibility of different building layouts within the design constraints defined by the engineering and construction teams. Engineers and Contractors can easily assess and modify the different structural concepts automatically proposed by the system to ensure buildability, cost, code compliance and low carbon impact.



A key advantage of using generative design in structural engineering is the ability to get sustainability insights about the design concept. There is universal agreement that sustainability should be considered as early as possible in the design life cycle, the same phases where generative design operates, giving us a great opportunity to combine the two.



Currently, the assessment of embodied carbon is only done at later design stages when a bill of materials is available. However, it is often too late to make major changes to the design concept by this stage. Kratos uses the massing model available at early design stages to generate a detailed structure including foundations and lateral load resisting systems. This allows a bill of materials to be extracted for accurate cost and embodied carbon assessment allowing more informed decisions to be made.



DAISY AI - Automated, production-ready timber designs

Go to [Daisy.ai](https://daisy.ai) and test it for yourself.

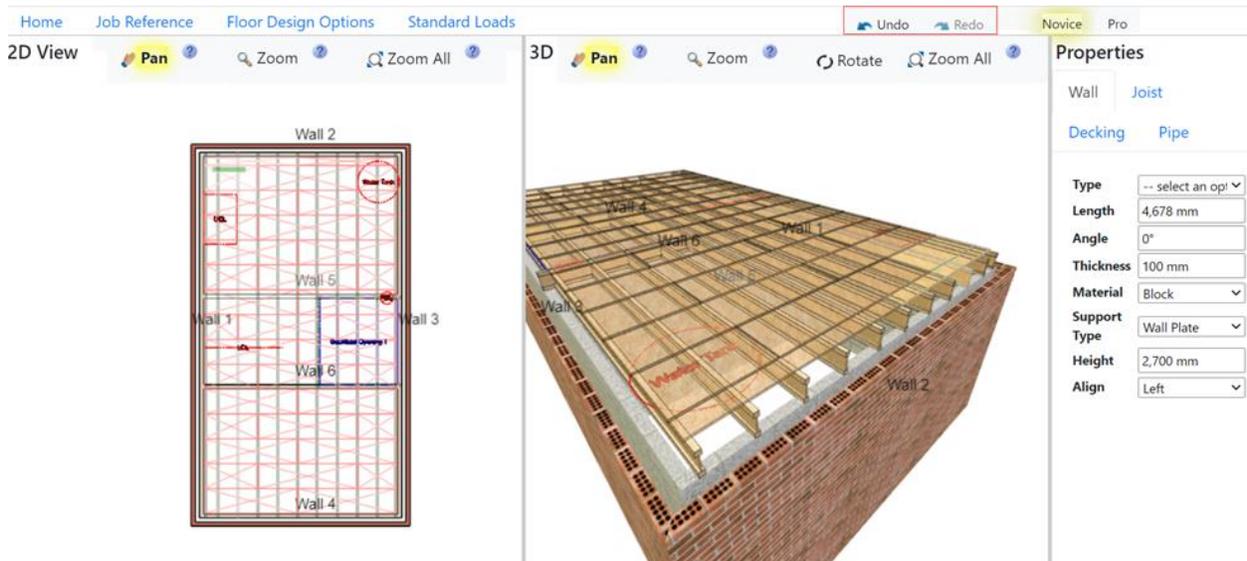
Getting AI to work on a theoretical level is a completely different task from making it actually work in practice. There are so many intricacies in developing a production-ready construction design, it is a very difficult process to automate.

DAISY AI is the first fully automated timber design software available on the market. It outputs optimized, code-compliant, production ready designs. It is a cloud-based application which allows all teams working on the project, i.e., architects, engineers and builders to see the evolution of a design in real-time by simply logging in to the platform.

The process of designing a timber floor takes a structural engineer on average 2-3 hours. DAISY outputs a fully optimized design in under 10 minutes, and it can work 24/7 meaning you now have an unlimited design capability. Upload your empty floor layouts into DAISY before going home in the evening and come to work in the morning with your designs being ready in your inbox.

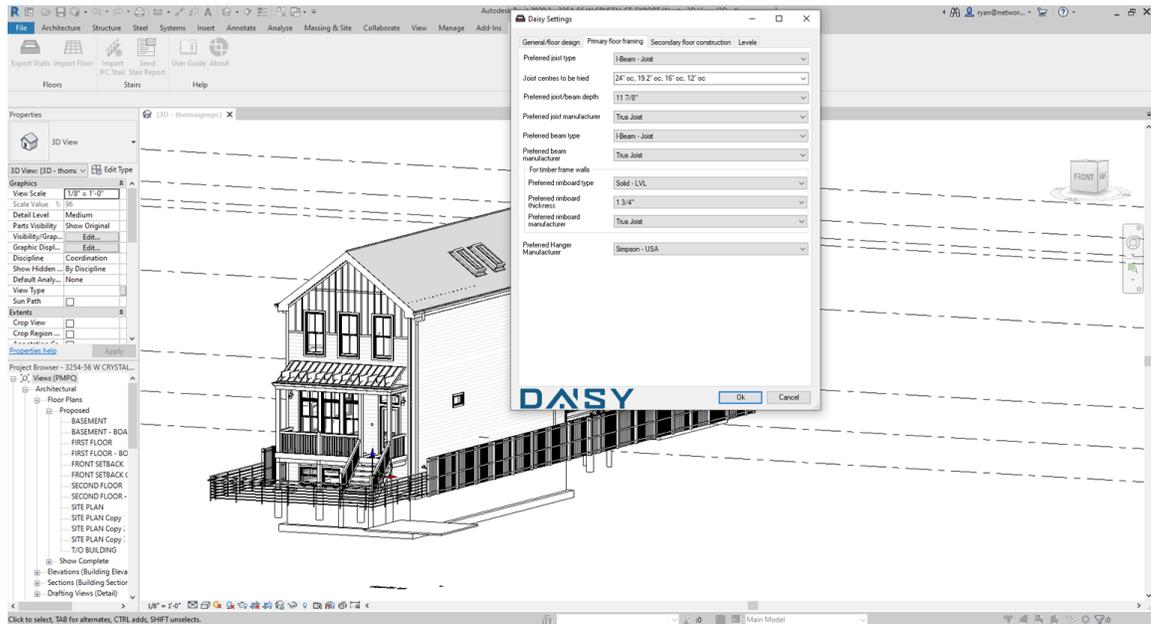
CAD Interface

You can draw the walls inside of DAISY, using its very own CAD interface.



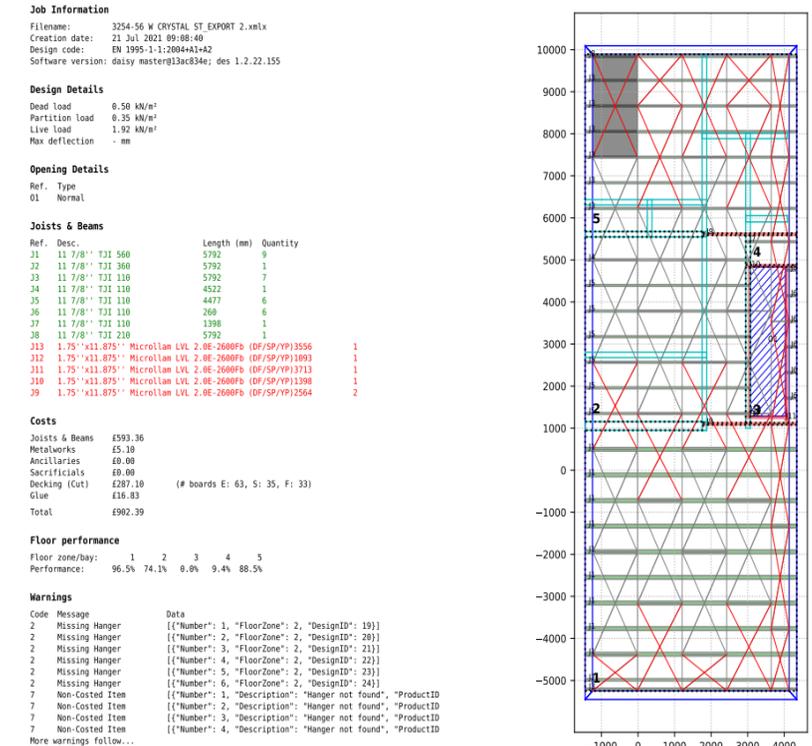
Revit Plugin

You can also download an xml file from Revit and upload it into DAISY to get your design.



DAISY Output Example

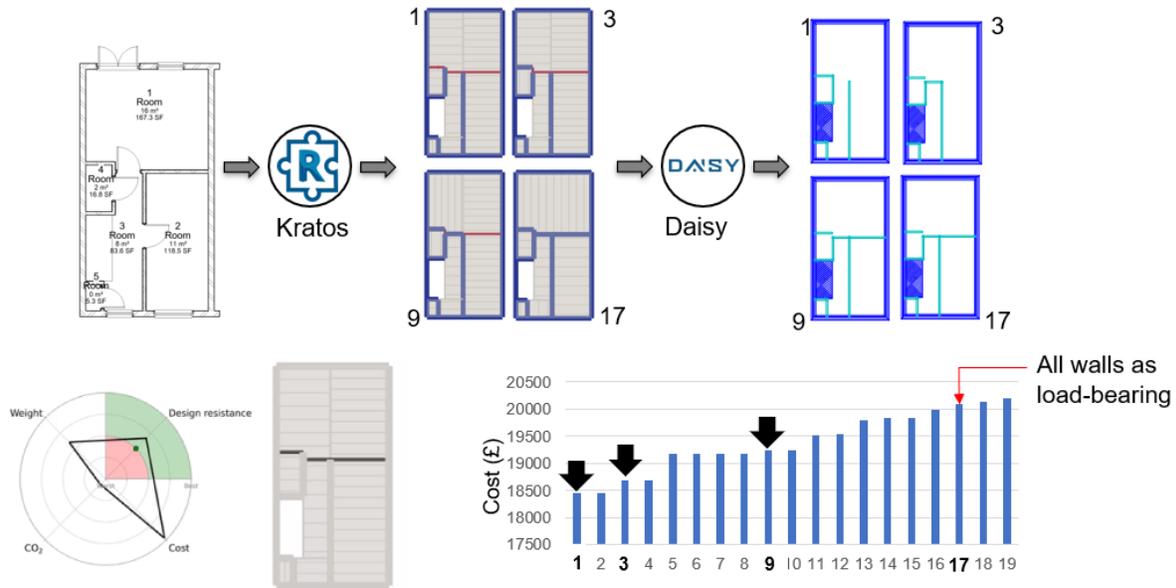
After about 10 minutes download your fully optimized design, including all of the coordinates and joist and beams information in order to build the floor.



DAISY & Kratos collaboration

Our collaboration started in 2020 when we first figured out that Kratos and DAISY's capabilities do in fact complement each other. DAISY can design timber floors, but it currently doesn't do walls. We teamed up to produce a design that optimizes for both, the load bearing walls as well as the final timber floor design.

The input was a popular rectangular floor layout in a British house design. First Kratos found four most optimal solutions for load bearing walls to minimize the construction cost, DAISY then produced designs for those top 4 and derived the final output which gave a fully optimized design with lowest overall cost.



Why is all this important?

The construction industry accounts for nearly 40% of annual global carbon emissions. Using sustainable building materials smartly optimized and scaled for each project can result in greener construction with greater cost savings. While timber offers a more sustainable option than materials like concrete and steel, it can be an expensive and complex investment with challenging design considerations and high material waste potential.



Designs optimized thanks to new technologies such as DAISY or Kratos can save an estimated 20% of construction materials, compared to sub-optimal designs produced by the less experienced engineers. In residential timber construction for example, this can mean that we could cut 20% less trees to build our homes and reduce the CO2 emissions generated on the transportation of wood to the construction sites.

If you would like to learn more about our mission of reducing carbon footprint of the construction sector with Artificial Intelligence, email our teams at kasia@daisy.ai or kosala.bandara@autodesk.com