Factsheet

Generative Design

human expertise meets artificial intelligence

How STRABAG is using algorithms to optimise building design

For STRABAG, data and digitalised processes are key tools with which to transform the construction industry. The use of big data and corresponding algorithms not only makes it possible to generate various deductions and forecasts but also to pursue specific goals in the design. This is precisely the aim of generative design. The model-based design method offers building planners countless possibilities for designing their structures. And generative design unfolds its full potential thanks to the combination of artificial intelligence and human expertise.

Generative design offers STRABAG a design tool for leveraging various data potentials that make construction not only more innovative, but also more sustainable. The possibility to influence resources, quality, costs and deadlines is greatest in the early planning and design phases of a construction project. Generative design, unlike previous practice, offers not just three or four design drafts, but a whole multitude of them. This saves time and resources in the search for the optimal design solution – fast, automated and data-based.

The Group benefits from the symbiosis between development and application: STRABAG Innovation and Digitalisation is driving the tool's further evolution, while the planners at Zentrale Technik contribute their practical experience.

"Automation and networking are the key to modern and sustainable construction. Generative design combines both."

Dr Marco Xaver Bornschlegl,
Head of Central Division
STRABAG Innovation & Digitalisation

ZÜBLIN STRABAG
WORK ON PROGRESS

Generative design: a principle in three steps

Generative design works with automatically generated data. In the computer-aided design process, evolutionary algorithms and optimisation methods generate a large number of design alternatives in a very short amount of time. These are created by combining the design variables of a parametric model. The principle of generative design can be explained in three steps:

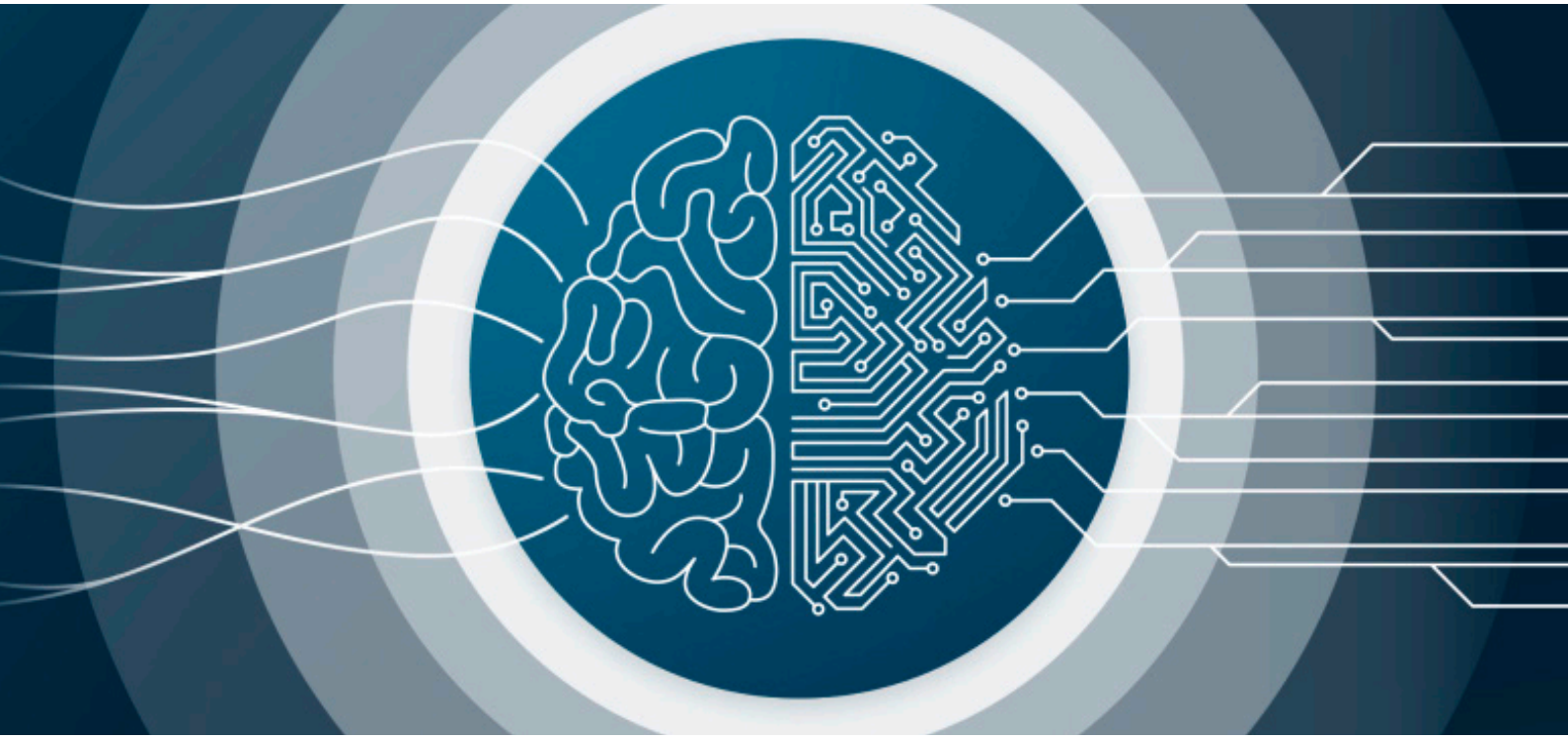
Generate
Hundreds of design proposals are generated in a very short amount of time. Innovative results are created that might have remained undiscovered with manual design planning.

Analyse
The system analyses the design variants with regard to the optimisation goals. Design specifications, including the defined parameters and spatial conditions, are automatically taken into account.

Optimise
The result: optimised design proposals based on the previously defined requirements and goals. The most suitable variant is then chosen and further adapted if necessary.

The benefits of generative design

- **Best possible solution** thanks to computation-based form-finding methods
- **Quality assurance** through automatic feasibility study
- **Diverse ideation** – fast, automated and data-based
- **Complex specifications** can be met more quickly and more cost-effectively with AI
- **Time-saving methodology** promotes innovative thinking



> We are rethinking planning and design. What we want are automated processes. We translate architectural and construction knowledge into algorithms to automate the design process. On this basis, we can also start optimising the buildings themselves.
>
> **Fabian Evers,**
> Function Lead Generative Design, STRABAG Innovation & Digitalisation

Tools & functions at a glance

Generative design is used in a wide range of applications: in civil engineering for the optimisation of shoring walls, in structural engineering for the automated planning of standard staircases or for the creation of optimal energy concepts. Basically, generative design can be used for any clearly describable design work. Some generative design tools are already an integral part of the design and planning processes.

GD ENERGY

GD ENERGY determines the heat load, cooling load and air volumes – in real time. Reliable results for project planning are generated within a very short period. Stored climate data records can be used to determine the photovoltaic (PV) yield and optimise the PV surfaces. The annual energy demand of the heating system can also be calculated automatically for CO2 assessment measurements during operation.

GD CO_2 & COST

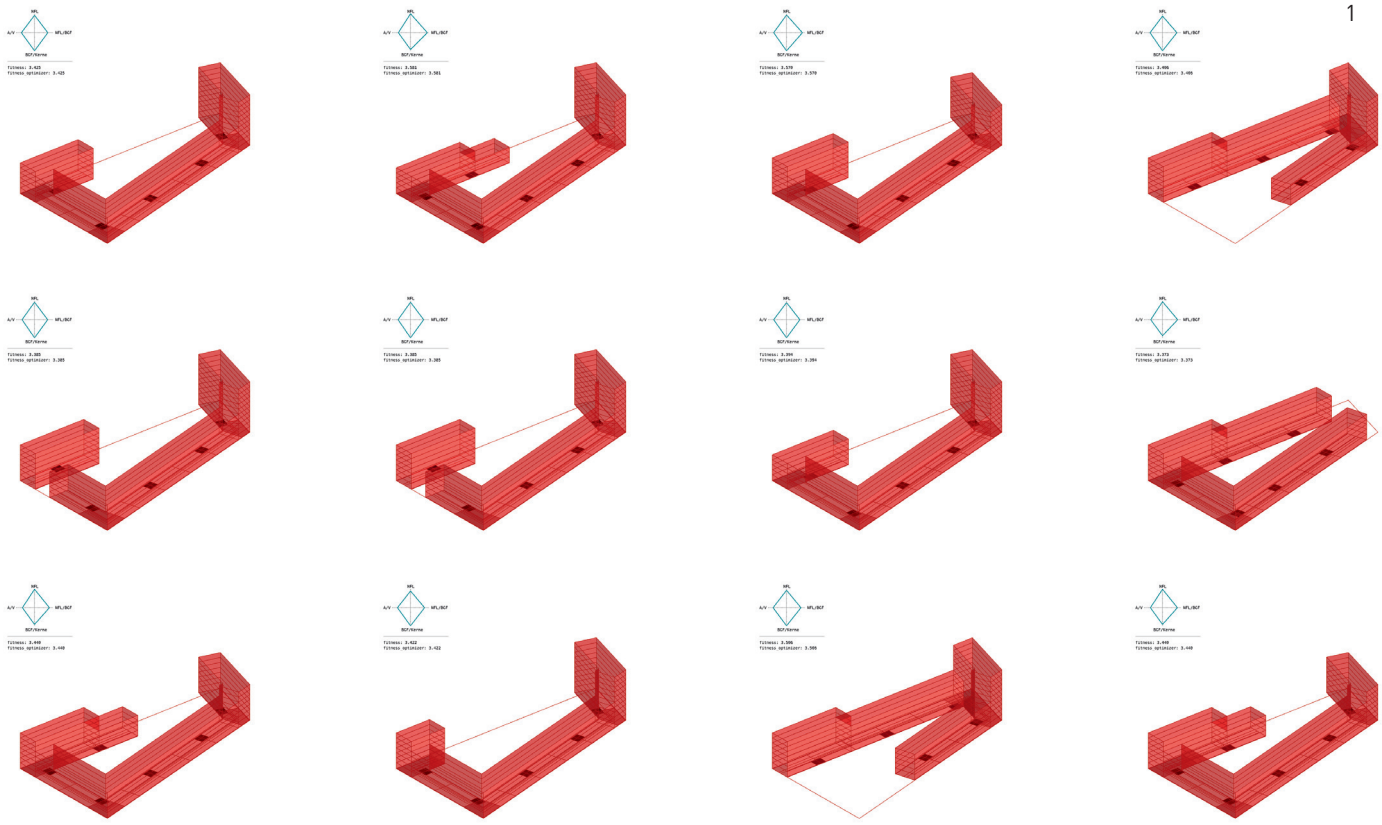
The tool offers an interactive user interface for examining variants and optimising designs for the early architectural service phases. The individual parameters of a building are analysed and optimised in terms of carbon emissions and production costs in the design.

GD ARCHITECTURE

Automatic generation of a counter-rotating, two-part precast staircase with support. The tool can be used to optimise not only the geometry of the handrail and banister, but also the step size.

GD EXCAVATION PIT

The tool contributes to considerable time and cost savings through the use of intelligent algorithms and optimises the classic design and planning process in the design of excavation pits. The system automatically generates hundreds of shoring variants, optimised in terms of CO_2 and costs.

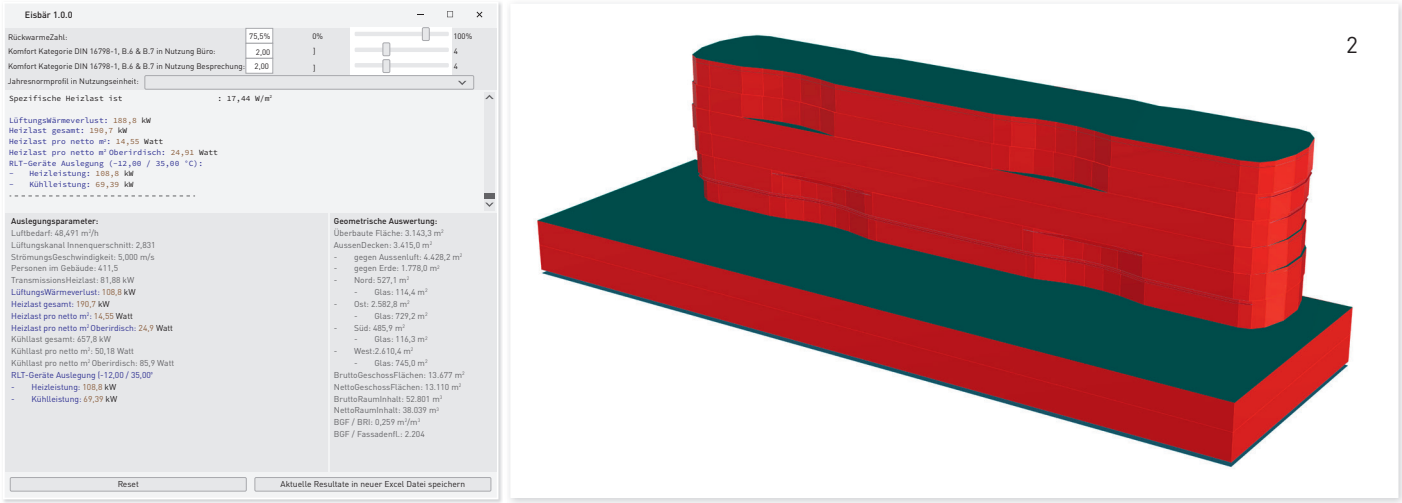


1 Generative design generates hundreds of design variants within a very short time.

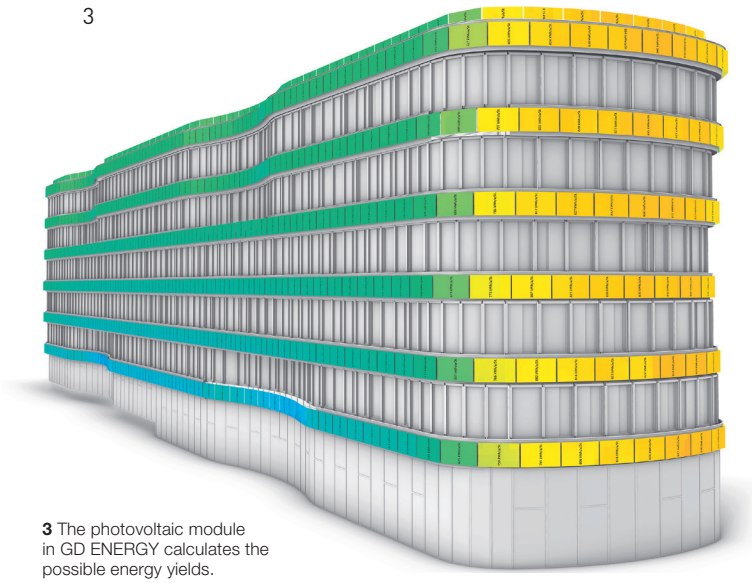
Generative design in use: decarbonisation of existing buildings with GD ENERGY

The STRABAG planners are already using generative design in the ongoing Z2 construction project at the ZÜBLIN Campus in Stuttgart. The planned refurbishment of the existing building offers numerous opportunities for using digital tools, especially GD ENERGY.

GD ENERGY allows STRABAG to parametrically model the existing building and evaluate its energy efficiency right from the initial design and planning phase. Based on data from Google Earth and using the escape and rescue route plans, the planners determine the design parameters such as air volumes and heat and cooling loads in the preliminary design. The building's potential PV yield can also be generated using the stored geographical data (GIS) and compared with the primary energy specifications in accordance with the Buildings Energy Act. So by using generative design, STRABAG is helping to create a climate-neutral, future-proof building.

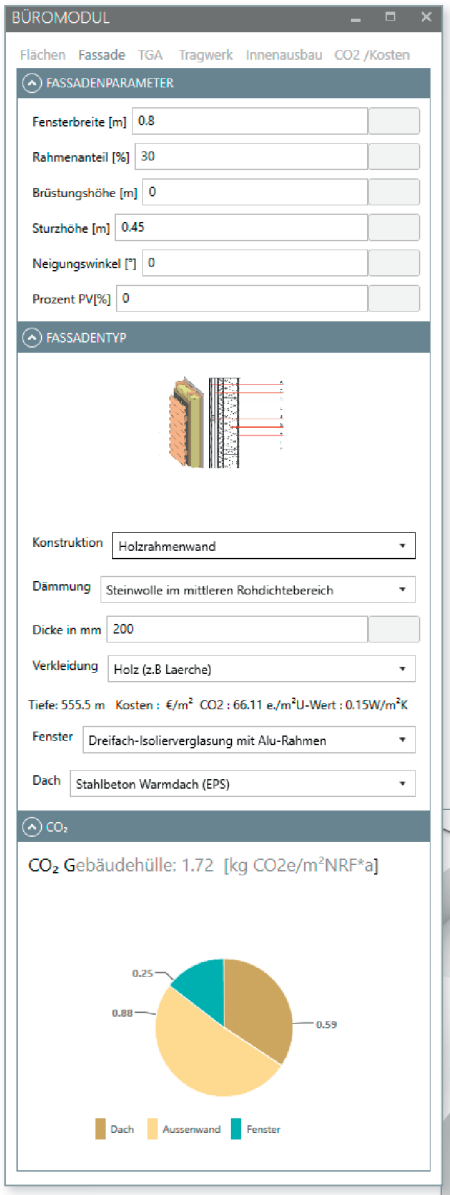


2 Building energy assessment using the example of Z2 at the ZÜBLIN Campus in Stuttgart.



3 The photovoltaic module in GD ENERGY calculates the possible energy yields.

The tool's user interface can be adapted as required, allowing users to work quickly and easily with the parameters of the 3D model and to consider a large number of possible variants. During the renovation of Z2, these parameters included the degree of heat recovery of the planned ventilation system and the physical properties of the façade. This made it possible to speed up the design and evaluation of the building services by 50–70% compared to a conventional design and planning process.



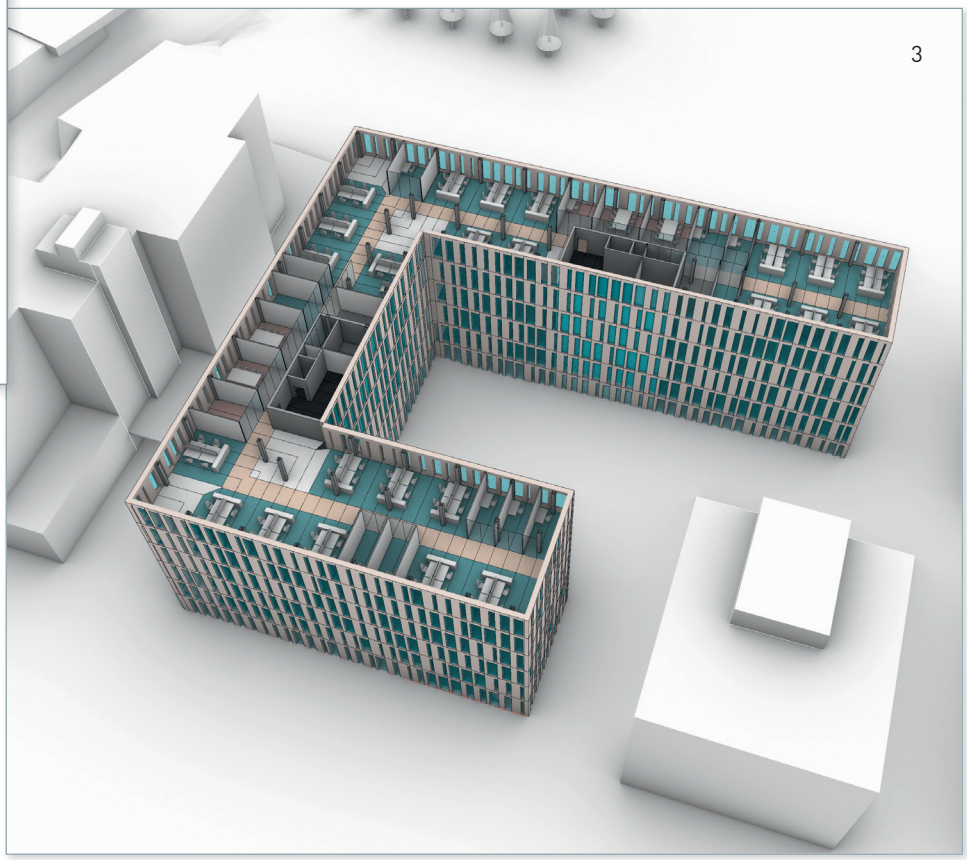
3 The Innovation Center in Stuttgart is a pilot project under the GD framework.

> Generative design relieves us of time-consuming processes in modelling or data evaluation. These things will be automated in the future giving us more time for basic conceptual design. If we use innovative applications such as GD in a targeted manner, we can make construction more sustainable, safer and more efficient.
>
> **Annerose Bierer,**
> Project Manager General Planning, Zentrale Technik

Outlook & next steps

STRABAG currently uses four generative design tools. The next step is to link these tools even more closely with each other in order to make the entire planning and design process more interactive. The goal is to be able to view the building as a whole and across several planning and design disciplines simultaneously.

One of the pilot projects for the application of the GD framework in the context of networked planning is the Innovation Center at the ZÜBLIN Campus in Stuttgart. From the design planning to the structural design to the office space design and building services design, everything here is automatically networked on a data basis.



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