Does Generative Design Really Support Sustainable Engineering Practices?

During a presentation on Autodesk's software advancements, I discovered Generative Design and its ability to revolutionize the traditional design process. The lecturer recalled a case study where General Motors requested an innovative new seatbelt bracket produced by Generative Design software for one of their vehicle models. The result was a complex, organic looking component with a 40% weight reduction (1) and 20% strength increase. The process reduced the part from 8 pieces to 1 (2), minimizing assembly times and cost. This extreme weight reduction would increase the overall efficiency of the vehicle as well as minimize material costs. Due to the complex nature of the part, it would, however, be challenging to manufacture and exceedingly difficult to be repaired by local garages. This led me to ask the question: Does Generative Design really support Sustainability?

The process of using Generative Design software is simple. The engineer inputs their chosen parameters and constraints, selects which properties that the product should be optimized for and then once the simulation is run, filters through the output design solutions and can iterate upon these further. By streamlining the design process, GD facilitates the integration of sustainability and environmental considerations into designs more efficiently and economically compared to conventional methods. For instance, by constraining the system to only generate designs incorporating sustainable materials, employing less energy-intensive manufacturing methods or by minimizing material volume, designs can achieve significantly higher sustainability. This provides companies with a much larger incentive to produce more sustainable products, without incurring additional time and cost expenditures.

Due to the immense computing power involved in the process of Generative Design, products and components can be optimized for their given purpose to a much higher degree than those designed by humans. For instance, the software has been adapted for architectural purposes to help design buildings that maximize the amount of natural light inside (3). With buildings consuming 40% of the world's energy supply (4), this can have an immense impact on carbon emissions. Similarly, the software has been used to generate the most optimal build process for civil engineering and construction projects (5). By iterating through many possible scenarios and operations, it can define the quickest and most efficient method for the build process – even down to the finite details such as lorry placement. However, to run the numerous simulations required to bring a product from the design phase to manufacturing and even to construction, many high-power GPUs are required which consume large amounts of energy. This process can therefore be a trade off between energy consumption in the design stage and energy reduction in the consumer market stage.

Overall, I believe that generative design does support sustainable engineering practices, so long as it is given the opportunity by the design engineer. It allows products – that otherwise would have a highly detrimental impact on the environment – to be much more sustainable, without the need for increased design time. The direct energy that it uses to carry out simulations is almost always accounted for once the product rolls out into the market, especially as the software is developed further and its computational efficiency is increased.

Using Chat GPT proved beneficial by inspiring topic ideas; giving rapid responses to questions about the process of GD, as well as rewording phrases to improve them both grammatically and in precision. However, its limitations include the inability to add a personal touch or provide opinionated concepts.

Link to Chat GPT Prompts: https://chat.openai.com/share/f2f481fe-971c-4c59-9e8a-ec135685f5b8

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