

FACULTY OF ARCHITECTURE, WARSAW UNIVERSITY OF TECHNOLOGY

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**Digital methods of supporting architectural design process
- and the analysis of the carbon footprint of buildings**

DOCTORAL DISSERTATION

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SUMMARY

The dissertation entitled "Digital methods of supporting architectural design process - and the analysis of the carbon footprint of buildings" concerns the current issues of shaping sustainable and climate-neutral architecture.

In the theoretical part, the author, through literature research, analyzes the issues of carbon footprint and climate change in the context of architectural design. A method of assessing the carbon footprint of buildings is described, based on the analysis of individual design decisions affecting its level. Individual design decisions are discussed and analyzed on the basis of the author's own experience and conducted research. Next, the author presents methods of supporting the integrated design process, which are based on the use of algorithms and machine learning, in the context of using them to reduce the carbon footprint of a building during the design process.

In the experimental part, the author conducts a series of studies aimed at creating a tool supporting the architect's design process in terms of optimizing the carbon footprint of the designed building. In subsequent experiments, the author looks for ways to increasingly automate and accelerate the process of optimizing the carbon footprint of the designed building. The methods analyzed include spreadsheets, genetic algorithms and machine learning. The author bases the final tool on the use of machine learning, which makes it possible to estimate the result without conducting simulations. As a result, a method is developed that allows to predict the carbon footprint of a building at an early, conceptual stage of the design process. The author also carries out the full process of preparing such a tool - from creating a neural network architecture, through conducting own simulations to prepare a set of training data, then through the process of training the machine learning model, to using the trained model in the process of predicting the result and using it in an exemplary design process.

The final part of the work presents the test record of the developed tool on the example of a conceptual design and the optimization of the carbon footprint of the building. The dissertation ends with a summary and conclusions describing the benefits of using digital design tools.

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