

## Reflection Martijn Nijkamp

The objective of this thesis was to establish a critical overview of the strengths and weaknesses of additive manufacturing in the context of the built environment and explore how these strengths and limitations influence the design process of mass-produced 3D printed solutions in the construction sector, with a particular focus on its potential to increase resilience in the built environment, which is an important consideration in the context of current societal and climate-related predicaments. To achieve this, an approach was chosen that was twofold. The first part of the research focused critically on the current applications of additive manufacturing in the built environment and assess its feasibility. It was concluded that for 3D printing to be a feasible manufacturing method, it has to be deployed to solve multi-faceted problems by producing complex, multi-functional parts that solve multiple problems at once. It was then concluded that this was most likely to be achieved in the field of climate design, as it was identified that such multidimensional problems were most common in the field of climate design. On top of that, research into 3D printing in the fields of structural and facade design was found to be plentiful and well established. After identifying potential research directions within climate design, it was concluded that for the objective of this paper, natural ventilation, and in particular the role of background ventilators and how they could be improved using 3D printed fluid diode plates, filters and acoustic solutions, was the most promising direction to research further as a case study for the second part of the research, which focused on outlining how the strengths and weaknesses of 3D printing influence the design process. The second part of the thesis thus focused on understanding the passive and 3D printable methods available to improve background ventilators. Most of the research focused on the fluid diode plates, as research on them is scarce. Based on the results, the thesis proposed an optimization and selection method for the FDPs, so that the FDP can be generated to meet the needs of any specific case. At the same time, the optimal production method was explored, as well as a proposal on integrating the FDPs into a multi-functional background ventilator. This approach to the thesis was sufficient to the initial objective of the paper, namely to explore the consequences of the characteristics of 3D printing as a manufacturing method for mass-produced components. It led to the conclusion that to make 3D printing feasible, a holistic approach to the design process of building components had to be adapted, which was confirmed by existing literature. On the other hand, due to the broad nature of the thesis, the research stayed somewhat superficial, meaning that many of the ideas and concepts that were introduced will have to be tested and validated. Assessing the academic and societal impact of the thesis, it can be

concluded that 3D printing can play an important role in making the built environment more passive and therefore more resilient. However, it remains a complicated way of manufacturing, as the poor scalability of the technology remains a problematic issue. Therefore, the exploration of holistic design thinking to unlock 3D printing is an important consideration that came forth from this thesis. Additionally, successful improvement of background ventilators through resilient, 3D printed solutions might guarantee many, especially those in less wealthy countries, access to affordable, healthy, and quiet ventilation, which aligns with the qualifications set in the first part of this thesis as to what exactly counts as is societal value and innovation.