Optimizing the Ventilation System of Modular Space-In-Space Work Offices

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Introduction

This research was conducted in collaboration with BOW Systems in Almelo. BOW offers space-in-space work offices for a broad range of clients. In early 2025, they just launched their newest version, the Paperclip. The BOW unit has been on the market for a few months now, and BOW has recognized that some improvements are still needed for this newest version. Based on usage and customer reviews, the ventilation system is often cited as an underperforming aspect of the unit.

The aim of this research was to improve the performance of the ventilation system in BOW's modular units. In optimizing the ventilation system, key aspects for BOW must be considered. The main design problem was defined as follows:

The current ventilation system of BOW shows inadequate airflow performance. The system does not yet meet the desired minimum airflow of 30 m^3/h, as required by regulations, at level 2. The design problem challenges the optimization and redesign of the ventilation system of BOW to achieve a higher airflow and improve the overall ventilation system, taking into account cost, quality, and duration of implementation.

To address the design problem, various rounds of testing are conducted in order to detect bottlenecks and evaluate potential improvements. Through different solutions, such as mechanical, software, and design solutions, this design problem was solved.

Approach

The research and design process is based on the Research through design approach, supported by the Design thinking method. The Research through design approach stands for acquiring insights through the act of designing, where the process, decision, and context are central [1]. Additionally, Design Thinking emphasizes a continuous cycle of inspiration, ideation, and implementation [2]. The iterative nature of this study allowed for continuous feedback and improvements. Inspiration and foundational knowledge were gathered through stakeholders, the target audience, information on ventilation, market analysis, and a case study. These formed the basis for starting the ideation, leading up to the realization and implementation of the final design. Fundamentally, the design thinking underpins this research, and the research through design informs the reflection and understanding of the findings.

Results

Each of the explored solutions showed potential results. However, the most impactful outcomes came from the software and design-based solutions. The software solution showed that by adjusting code parameters related to voltage supply and fan speeds, the airflow could be increased. In the design solution, the duct silencer was redesigned, as tests identified that the most resistance in the ventilation system was created by this part. The redesign is shown in the following figures.

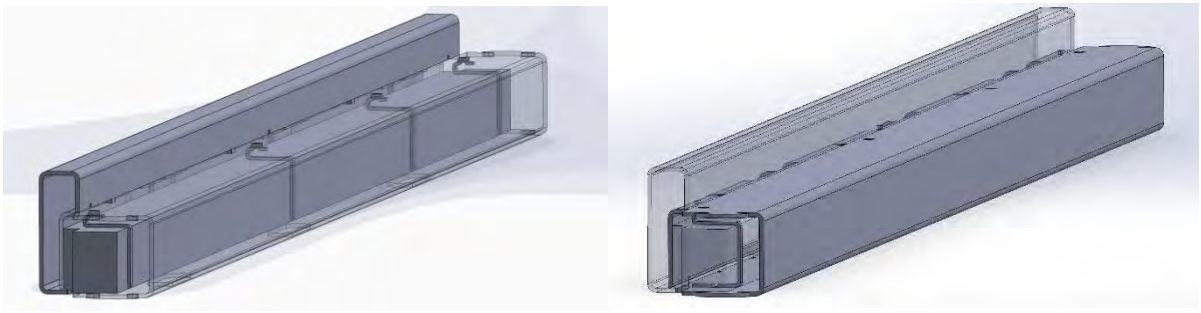

Figure 1. Redesign of the duct silencer with one transparent part for better view.

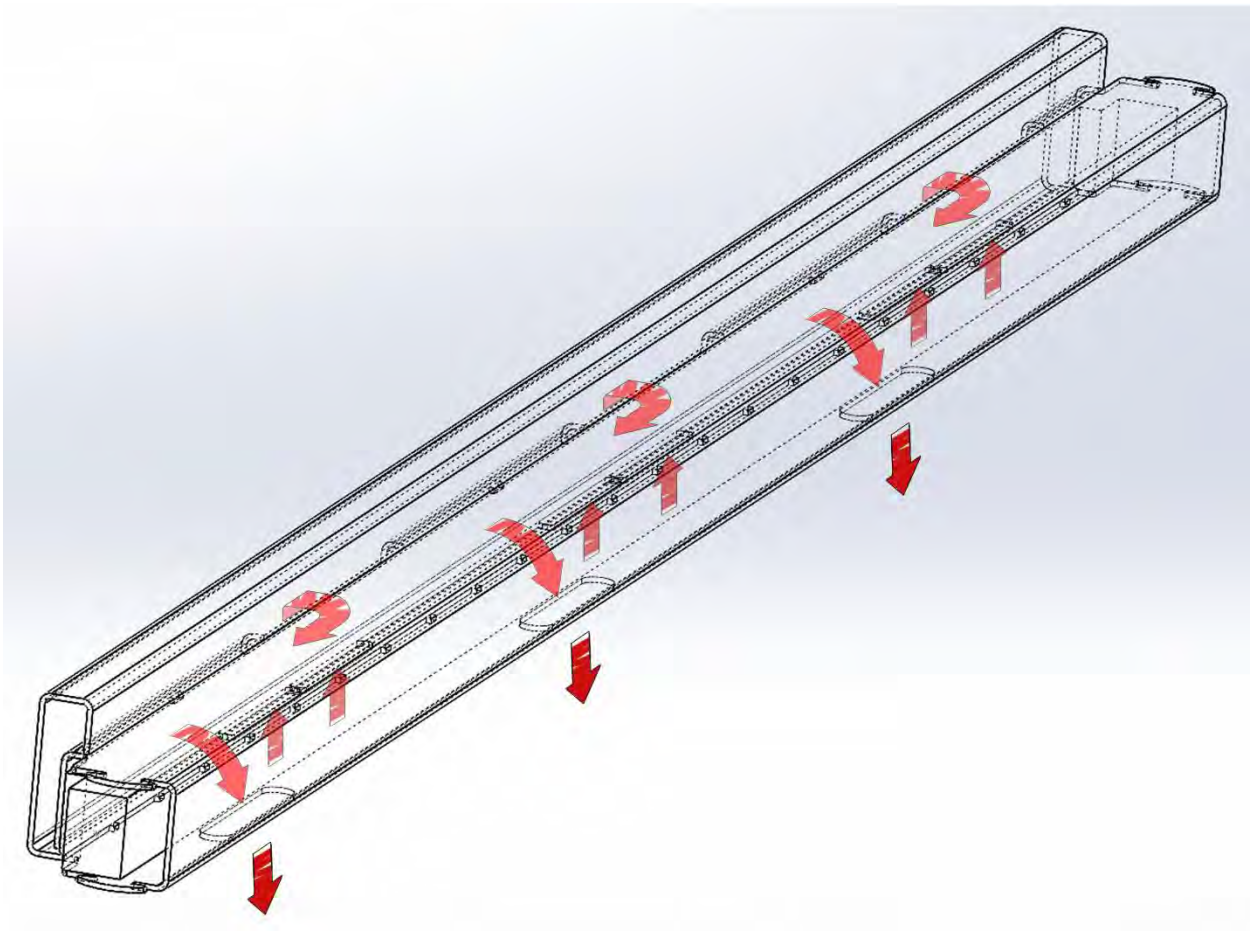

Figure 2. Airflow within the redesigned duct silencer.

In this redesign, all air passages, including supply and drain holes, are equally sized, allowing for fluent airflow and lowered resistance. The travel distance for the air is shortened, lowering resistance. Moreover, a representative pattern is included to allow a bigger volume of air to enter the unit and increase the considered smallest cross-sectional area. Additionally, this redesign includes absorption material to lower noise pollution through the duct silencers. The absorption material counteracts the added sound leaking of the system, as more air passages allow not only air but also sound to pass through.

Conclusion and recommendations

This research has provided BOW systems with a viable and realistic solution to their design problem of inadequate ventilation through their units. Through proposed solutions, the following timeline showcases the recommendations of this study. In the short term, BOW can implement the software solution to increase the voltage parameters to enhance the airflow directly. Additionally, BOW could implement the proposed redesigned duct silencer to remove its biggest structural bottleneck. Further research is suggested into these recommendations, possibly offering additional insights, helping BOW to continue refining their product in the future.

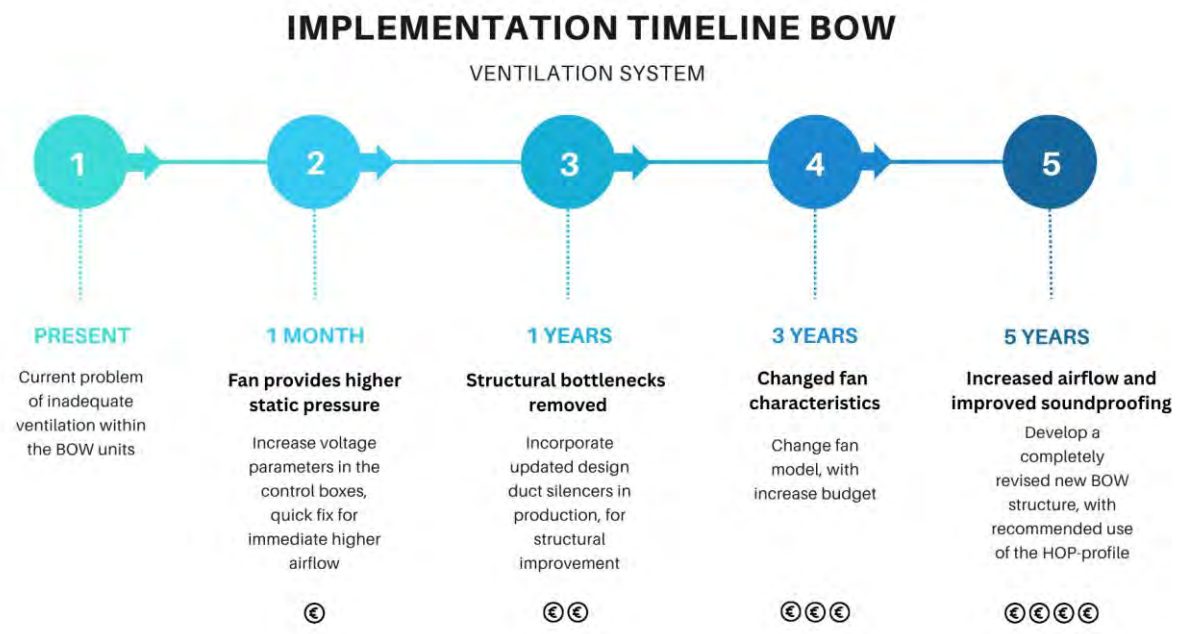

Figure 3. Implementation timeline for BOW.

References

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