Designing a Variable Volume Controller

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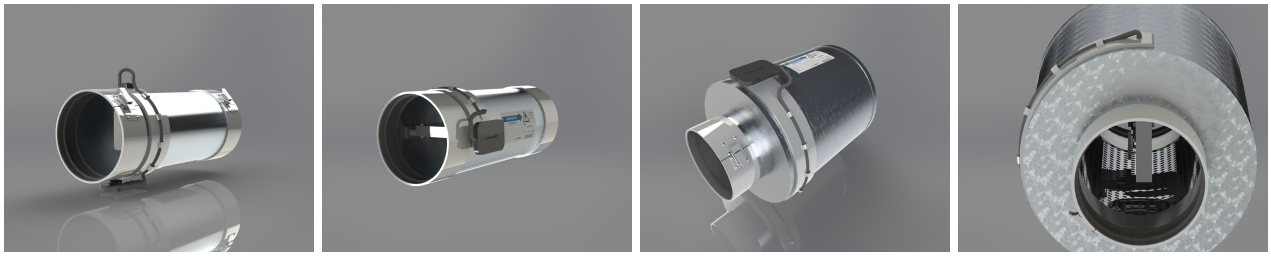
Designing a Variable Volume Controller for Celsius Benelux using a pre-determined actuator

Celsius Benelux offered this assignment. Celsius Benelux is a company that specialises in Building management control. Four years ago, Celsius decided to start producing their own products, to reduce costs and be cost-effective. Celsius is currently producing two products: The Integrated Smart Sense (ISS) and the Integrated Multi Sensor (IMS) [1]. These are an interface and sensor present in the room for climate control. Celsius wants to expand and produce their own variable volume controller (VAV). A VAV is a regulation unit that controls the amount of air that flows in a room, based on the air quality in that room. Celsius already has a prototype, which results in the following main research question: *How can Celsius' existing prototype of their variable volume controller be finalised into a professional-looking and finished concept?*.

To realise this research question, several subjects have been researched: existing prototype analysis, stakeholders analysis, company analysis, market analysis, heat transfer research and sound absorption research. The existing prototype has been conducted by field research. During this analysis, the preliminary VAV has been manually produced, and subsequently installed at a build site. This showed that the measurement and drilling during the production were too time-intensive, and the connection plug should be on the bottom side of the VAV to make the VAV more user-friendly.
The market has been analysed by intensively scanning brochures and websites of the competitors. The most important aspect of the market analysis was the VAV characteristics. This analysis culminated in the requirement of airtightness for the casing of class C, and the valve class 3, which are classifications according to the EN1751 standard [2]. The market analysis showed that airtightness is the most important characteristic for the competitiveness of a VAV.
The stakeholders have been analysed using open interviews. These interviews were analysed to state requirements for the requirements. The most important requirements are the serviceability of the VAV and the need for a low cost price of the VAV. Also a maximum cost price has been established. The heat transfer and sound absorption research were done using literature research. Several technical requirements were stated from this literature research, such as a thickness of 50mm for the insulation layer. The most important conclusion from the heat transfer and sound absorption is that both processes are caused by porosity. Therefore the decision was made to combine both VAVs into one version, which can be seen in figure 1c and 1d

After the research, the requirements were realised during the design process. The final design makes use of a visual addition, which gives the VAV a distinctive exterior. The design characteristics of Celsius have been implemented within the design. The visual addition also helps to reduce the air leakage of the casing by removing the need for additional holes. Several further additions have been made to the VAV to improve airtightness, such as a polyurethane sealing rubber valve. The final design of the VAV can be seen in figure 1. The final design of the VAV has a distinctive professional exterior and is competitive within the market. Clamps are also added to the final design of the VAV, to make sure the VAV is serviceable after it has been put into operation.



(a) Side view VAV (b) Bottom view VAV (c) Side view insulated VAV (d) Front view insulated VAV

Figure 1: Overall caption for all subfigures

However, testing has not yet been done to confirm the airtightness classifications. Also, the lifespan of the VAV needs further research. Although the design of the sound-absorbing VAV has also been realised, the prototype has not been realised. In addition, producing the sound-absorbing VAV is not feasible for Celsius. Nonetheless, the research on sound absorption and heat transfer laid the foundation for further design, such as a pre-fab heat-insulated version or a separate silencer. Another requirement that has not been met is the cost price of the VAV. The cost price is slightly too high. Nonetheless, the cost price is still within range, and producing the VAV is still feasible. The main research question was to design a professional and finished VAV. This research question has been successfully answered for the most part, although some problems arise with the sound-absorbing VAV. In addition, not all the requirements have been confirmed, such as the airtightness and the lifespan of the VAV. That is also one of the future direction recommendations. The first recommendation is to officially test the airtightness and the lifespan. However, the airtightness is considered to be sufficient. This is based on the comparison of the valve and casing of the competitors. The most important recommendation is to drop the sound-absorbing VAV project. Realising an airtight valve for the sound-absorbing VAV would be difficult and in addition, producing the VAV in the workshop of Celsius is not feasible.

References

[1] Over ons — celsius benelux b.v. `https://www.celsiusbenelux.nl/over-ons`. (Accessed on 12/18/2023).

[2] Nen-en 1751:2014 en. `https://www.nen.nl/nen-en-1751-2014-en-192066`. (Accessed on 12/18/2023).