

The fixed shutter panels from Livium BV needed a re-design to improve assembling and mounting of their fixed shutter panels, since this is now time consuming and not ergonomic for the assembly mechanics. Livium offers two kinds of fixed shutter panels, either centred-fixed (figure 1) or bracket-fixed (figure 2). The kind of shutter panel that is chosen depends on the client's preferences and mounting possibilities at location. There are many different locations where a client could want a fixed shutter panel, but most common is in front of their windows. As no situation is the same, often custom solutions are required. In this thesis the re-design is tackled by answering the following main question:

*How to re-design the frame(s) of fixed shutter panels (centred-fixed and bracket-fixed), to make it a universal solution, which improves ease of assembly & mounting and therefore reduces overall costs?*



Figure 2

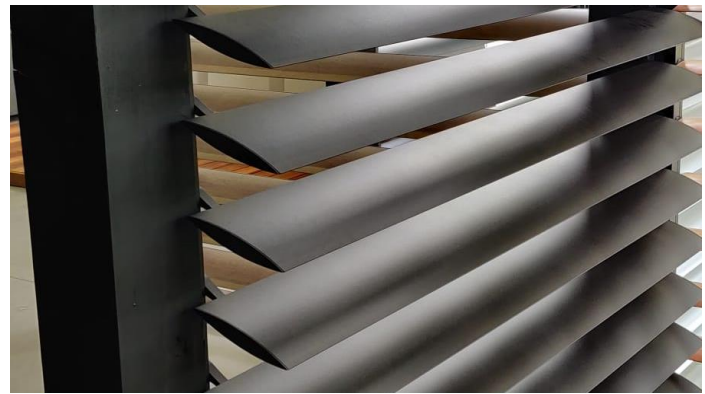


Figure 1

To start, Livium as a company was analysed. They are focused on making client specific, high quality products. Their products last a lifetime and aesthetics are important. It is important that the concepts in the end will fit the standards of Livium. A stakeholder analysis was made to find out what the different stakes are for every person in direct contact with the product. Expert interviews have been performed with the most important stakeholders to get to know their interests, problems and ideas. The interviews helped with analysing when, which shutter panel is chosen and how the different shutter panels are built up. Thereby, the assembly mechanics were able to tell what their problems are concerning assembling and mounting. It turned out that mounting shutter panels on a slanted surface, like in the top of a roof, is the most challenging. This made that the assignment was split up in multiple directions, straight centred-fixed, slanted centred-fixed, straight bracket-fixed & slanted bracket-fixed panels. This formed the basis of this research and multiple requirements followed from this.

For the centred-fixed shutter panels, the ergonomics while mounting the panel was a problem for the mechanics. These panels had to be assembled completely before they could be mounted at location. As these panels can become quite large and they always mount the panels with two men, this quickly becomes too heavy and unmanageable. Therefore research was done on how to re-design the assembly and mounting of the panels according to ergonomic standards.

Next products from competitors and Livium's other products were analysed to explore existing possibilities. Also a simple cost distribution was made using a few real cases as benchmark. Here production and assembly costs have been compared. From this a time distribution analysis about the development of the different panels was made, which gave a detailed representation where improvements could be made. Also some calculations were done about the thermal expansion and wind loads. This all lead to a list of requirements the re-design should abide by.

The requirements were the start of the creative phase. For each kind of panel, series of sketches have been made to explore the different possibilities, wherefrom several concept directions followed for each different panel. Some have been prototyped during the quick prototyping phase to take out flaws early on in the design process. Subsequently, concept solutions for all different shutter panels could be proposed. The re-designs were all validated using the requirements from the research phase and strength calculation have been done where necessary. A prototype of a straight centred-fixed shutter panel has been made in a realistic situation, which can be seen in figure 3, which proved the proposed solution worked as expected. At last, recommendations have been made regarding production and future improvements.

The centred-fixed shutter panels can now be mounted faster and more ergonomically, for the good of the assembly mechanics. Instead of having to mount the shutter panel as a whole, the blades can now be slit into a frame one by one. For the bracket-fixed shutter panels an extra bracket is added, which increases the productivity of the mechanics, since the blade brackets can now be turned up to mount the blades.



Figure 3