Trane – Filter Configuration and Optimization
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Problem
Trane is a major provider of air handling units worldwide. There manufacturing plant in Lexington, KY currently builds air handling units for commercial residencies. Trane’s current units are either standard sizes or fully custom sizes. They do not have any options which are semi-custom or semi-standard.

Trane wants to grab a foot hold in the semi-custom air handling market. To achieve this, a new product line needed to be created. Trane’s current idea is known as the variable aspect ratio units. This project will increase the unit size width and height in increments.

To successfully implement this project, all of the internal parts of the unit must be designed to work with the new semi-custom unit sizes. Filter frames are a large portion of the internal portion. All of the different filter frames must be designed in increments to fit within the semi-custom air handling unit.

Task, Budget, and Schedule
Our team has been tasked with the design and layout of the new filter frames. These filter frames will be similar in nature to the current frame designs used at Trane. The filter types that Trane offers include angled filters, side load flat filters, combination side load filters, combination front load filters, and HEPA filters. Each filter type has there own frame construction. Five different frames will need to be designed and then scaled to each of the unit sizes that will be available.

Our current budget will be provided by Trane. Trane wants each new filter frame to be similar in cost to what is currently manufactured. This means that the frames could vary from $1,000 to $4,000 depending on the size of the unit. Trane will also be providing the budget for the prototype.

The schedule of the project is being tracked on a Gantt chart. Currently we have passed our first design review presentation and are preparing for the second. No delays have occurred and final calculations and concept selections are currently being completed.

Goals, Objective, and Constraints
The goal of this project is to design a filter frame which is both efficient and cost effective while meeting all of the customer demands. These filter frames will help propel Trane into the semi-custom air handling market.

Objectives
• Low filter variability (only two sizes of filters)
• Small amount of parts (low cost)
• Stable
• Efficient
• Easy to services

Constraints
• Galvanized steel must be used
• Filters of size 24” X 24” and 12” X 24” only
• Height to width ratio must be reasonable
  • 0.31 < H/L < 2.00
• Height can only vary by 3”
• Width can only vary by 6”
• Minimum filter area is required for each size
• Minimum dimension – 42.5” tall X 48” wide
• Maximum dimension – 178” tall X 109.75” wide

Full Sheet Metal Frame Concept
Our first major concept is the idea of using a full sheet metal plate to construct the frame. In this concept, one sheet metal piece would be produced with the filter holes cut out.

Brackets would then be applied with adhesive above and below the holes for side load filters. Additional support would come in the form of horizontal and vertical brackets attached to the opposite side.

For front load filters, threaded rods or clips would be used to pull the filters into the sheet. Horizontal and vertical brackets, which would be located on the other side, would be attached with adhesive to provide stability. Side load block offs would be used to keep the filters in place.

Semi-Modular Sheet Metal Frame Concept
Our second major concept is the idea of using multiple horizontal or vertical sheet metal plates to construct the frame. Each sheet would be made for a single row or column with filter holes cut out.

For side load filters, the brackets would still be used as a track to slide the filters along. These brackets would be applied using industrial adhesive. Additional support and attachment brackets would be used to hold separate pieces together.

For front load filters, threaded rods and clips would be used to pull the filter flush with the face of the panel. For this idea to work, we would need to make sure that the seam doesn’t run through the filter or we could have gasket sealing issues. Again, additional support and attachment brackets would be used on the opposite side to hold everything together. Side load block offs would be used to keep the filters in place.

Semi-Modular Frame Concept for a USIZ 17 model

Modular Sheet Metal Frame Concept
Our third major concept is the idea of using a frame for each filter. The frames would then be combined using adhesives and brackets to complete the overall size of the frame. Each filter size would have their own pre-determined sheet.

For side load filters, individual tracks would be placed on each filter. Each filter section would then be put together using adhesives or brackets. Each section would also have their own cutout. There would also need to be sections which didn’t have cut outs to fill in the remaining space. Additional support would be provided by horizontal and vertical brackets on the opposite side of the filters.

For front load filters, it was determined that this concept would not be possible. Side load filters are lightweight compared to front load filters. With the added weight of the front load filters and the large number of seams there would be a large number of stress concentrations and possible failures.