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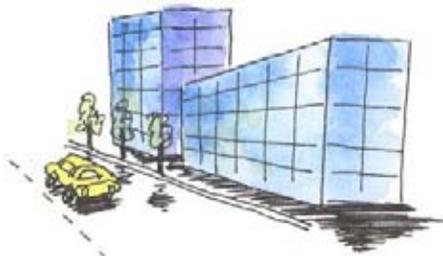
Aero-acoustical Facade Design Proposal

Summary

The design is an experiment of a facade system component that allows for adequate airflow for natural ventilation while absorbing outside noise. Once the basic airflow and acoustic parameters were defined, the additional challenge to admit daylight and provide views was considered. This product is applicable for an office in an urban environment in a temperate climate.

Sustainable Impact

Today, climatically-responsive buildings are designed at an unprecedented scale with the aid of high-tech facades combined with elaborate building management systems. Buildings consume over half of the nation's energy, implying potential for designers to prescribe significant energy savings. A thoughtful designer recognizes that air conditioning accounts for a significant portion of the building's energy use, and takes advantage of natural ventilation in appropriate climates. In addition to conserving energy, operable windows connect the occupants to the environment outside and lend a sense of control over their immediate surroundings. There is a need for an assembly that would allow for airflow comparable to an open window that mitigates outside noise.



Context: Street noise encourages typical offices to keep windows closed, preventing natural ventilation.

Genzyme Building Ventilation Strategies

The Genzyme building by Behnisch, Behnisch & Partner long with engineering firm Buro Happold demonstrates the energy-saving potential and occupant control benefits within the office building typology.

The Genzyme building relies on the stack effect of its 12-story atrium to exhaust air from much of the office space. The double-facade is a climatic buffer which selectively exaggerated into a four-foot deep 'loggia' space that becomes inhabitable during the milder spring and fall seasons. The operable windows allow for natural ventilation and night-cooling as energy-saving, comfort-inducing alternative to air conditioning.

The aero-acoustical window could be applied in the Genzyme building's facade to mitigate noise from surrounding construction sites. The product could also be used as an interior partition wall in areas that are 'sealed' meeting or offices, allowing air to travel from the perimeter to the atrium while providing acoustic privacy and preserving the aspirations for transparency.

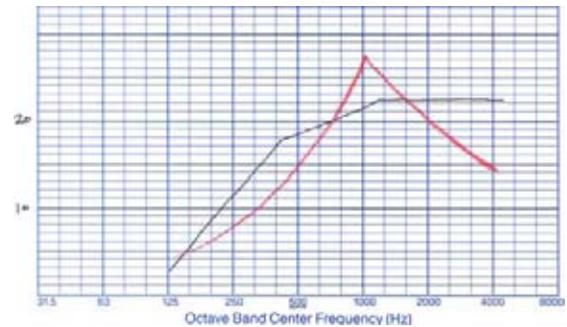
Research: Design Precedents

One major deterrent to using natural ventilation in an urban office is the justified fear that an open window will admit unwanted noise and dirt particles. This problem has been addressed in a number of commercially available products. For example, the acoustical louvres typically used in fan rooms are designed to allow for airflow while mitigating the noise from the HVAC equipment. The sound attenuation properties of these louvres would not be sufficient for the facade of an inhabited space such as an office. Another product currently on the market is a vent that may achieve the quantitative airflow and acoustic objectives, but lacks an aesthetically-pleasing, architecturally-integrated design.

The acoustic parameters were derived from a series of calculations with the assistance of MIT Building Technology student Omar Saad. Based on AHRAE guidelines for a 12”x12” duct 6’ in length, with a 1” thick fiberglass lining, the following graph was plotted and corresponding Sound Transmission Class (STC) ratings were derived.

Sound Transmission Class:

- Office with closed windows: 30
- Office with 5% open windows: 10
- Office with duct described above: 27



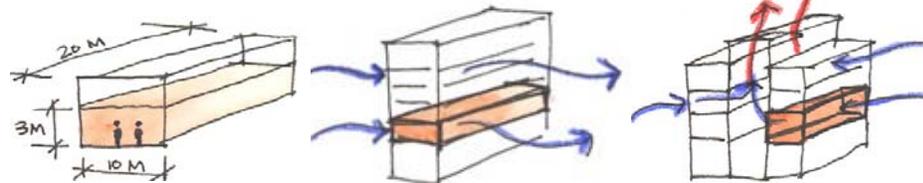
The plotted graph determines the STC rating of the duct described above.

Design Proposal

How might the airflow, acoustics, and daylight be optimally combined and integrated into a single product that can be integrated into an architectural facade?

First, design parameters for airflow and acoustic properties must be established. The airflow calculations were estimated with the assistance of Professor Leon Glicksman. The following assumptions suggest a base case from which further forms can be derived.

- Wind speed: 8 mph
- Ducts in facade: 6 feet long, 8” sq. cross-section
- % openings in façade: 5%
- Air changes/ hour: 11
- Office volume: 3 m tall x 10 m deep x 20 m long



Context: The proposed office volume (left) may be part of a cross ventilation system (middle) or buoyancy-driven system with an atrium (right).

These ratings demonstrate that with open windows, the occupants inside will perceive sound half as loud as the outside levels. The modeled duct is practically as effective as the closed windows (the difference between and STC rating of 27 and 30 is almost imperceptible).

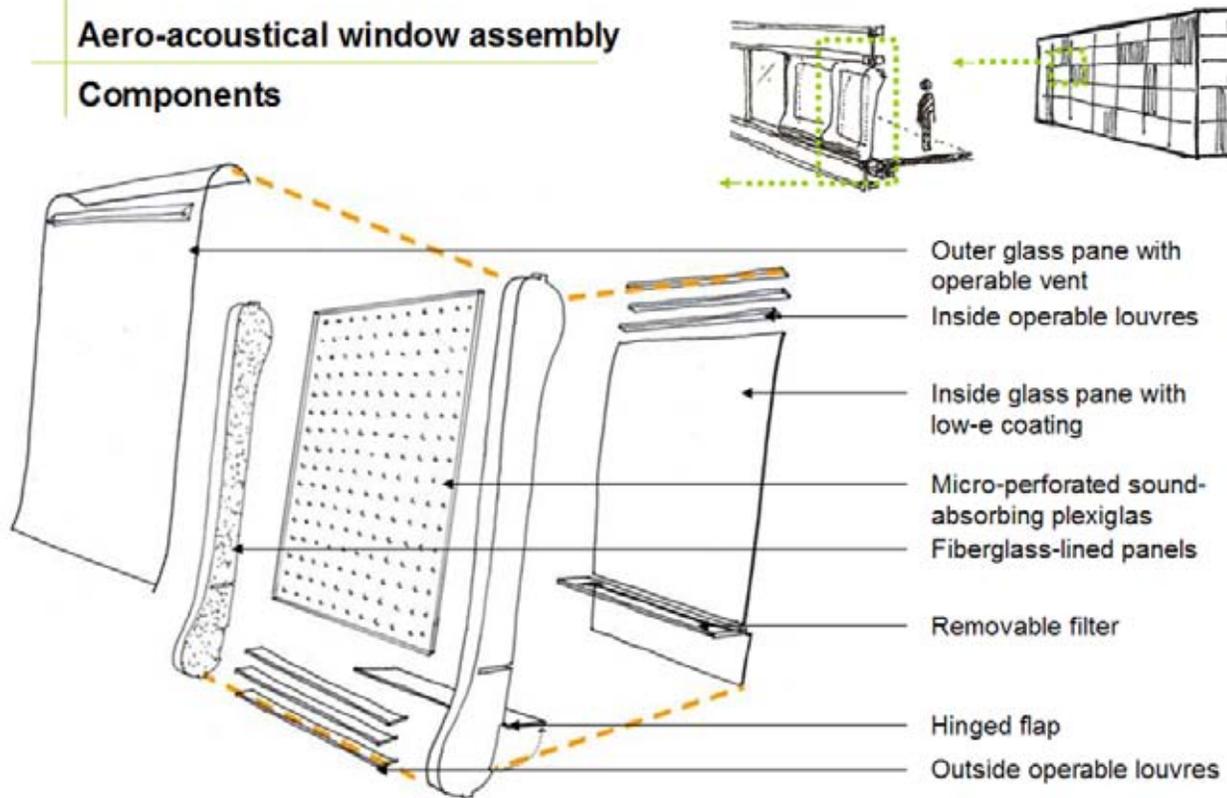
The duct described above is used as a reference point from which design ideas are initiated. The following designs would require physical testing to determine their effectiveness.

Design Proposal 1: Curtain Wall Component

The first design proposal is essentially a 6' tall double facade with operable vents, an air filtration device, fiberglass lining on two sides, and a sound-absorbing micro-perforated plexiglas in the interior cavity (a product marketed at microsorber.com). This assembly could be integrated into a typical glazed curtain wall facade. Its transparency allows for daylight penetration as well as views.

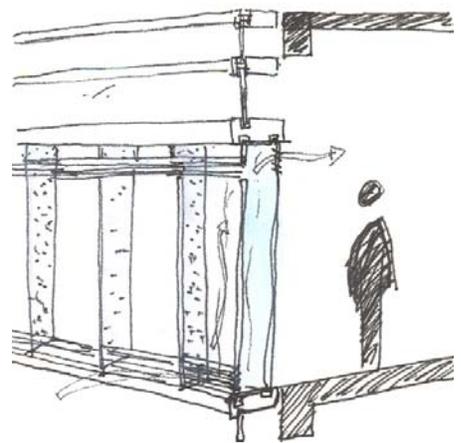


Aero-acoustical window assembly Components



Design Proposal 2: Undulating Glass

The second design proposal is a variation of the first proposal of 6' high panels suited to a curtain wall facade. It consists of undulating cast glass panes that might deflect sound waves within the double-skin cavity to the sound absorbing lining on the other two sides. The physical model is solid to demonstrate the curved surface, although in reality this might be constructed using a translucent cast glass.



Design Proposal 3: Tubular Series

The third design proposal envisions an atypical construction method where structural ribs are connected by a series of tubes which comprise the wall as well as provide ventilation. The fiberglass-lined tubes are 4' in length and have operable vents on both exterior and interior surfaces. Air-flow could be adjusted by the number of tubes vents opened at any given moment. The tubes are a translucent, water and weather-resistant material.

