"Double-leaf facades cost per square meter anywhere from 1,500 to 3,000 DM (about 665 to 1130 USD) and thus much more than well-insulated and finished single-leaf facades, while the energy savings often amounts to only approximately 2% to 4% of the extra investment. Hence, in the case of double-leaf facades, it is worth considering whether they should be marketed solely on the basis of energy savings or whether other essential aspects argue for their use." Klaus Daniels, "Low Tech, Light Tech, High Tech- Building in Information Age,"

Cooling load reduction: reducing cooling load can best be achieved, in approximate order of effectiveness, by using opaque wall elements, shading, and solar-control coatings.
Natural ventilation: …… requires means to deal with the simultaneous entry of noise, dust, insects, rain and snow. Protected, operable, screened and sound baffled openings can, and have, been incorporated into buildings.
Daylighting: a façade with 40 or 50% of its area covered in high visual transmission glazing can usually provide plenty of daylight deep into a building. Properly placed windows (e.g., light shelves and similar) have long been successfully used for daylighting. John Straube "Analysis of double facades for cool humid climates"

When compared to conventional walls, energy savings from all glass double envelopes are reported to range from as little as 5 percent to more than 40 percent. (Daniels 1998, Saleens 2000)

In Soontorm Boonyatikarn's paper titled "Performance of an airflow envelope", *the double envelope system is shown to have improved mean radiant temperature and thermal comfort when compared to conventional windows.* (Boonyatikarn, 1987)

In "Thermal performance of a supply-air window" by S.A Barabat, *The air flow through the window cavity was shown to recovered a large fraction of the heat loss. The overall reduction in purchased energy of the supply-air window unit relative to a similar double-glazed window unit or to a triple glazed window unit is about 25% and 20%, respectively.*

Jones, et. Al. in their paper titled "*Experimental study of the cooling season performance of ventilated double glass envelope cavities*" *shows that for south facing envelopes, on average about 45 percent of the solar radiation incident on the wall can be absorbed and removed from the cavity in naturally ventilated systems.* (Jones 2000)

The reason why people are so interested and enthusiastic about double glass facades is that people have high expectations of new technology. Although it is not really cost efficient, because it is new, people like to try it even without fully understanding the in-depth reasons. This social-psychological phenomenon is common and understandable. And because this technology is new, many questions remains unknown. The huge difference between performances of different double glass facade systems shows this. So, more study and research of the technology and system design should be done. At the same time, the intention of trying new things becomes the motivation behind double glass facade research. This is the power of new things, as the research about it is going on, the performance of the system will definitely be improving. So rather than approving the double glass facade as a cost efficient system, which has been done by most previous researchers, improving the design of double envelope systems is more important. In this project, I have attempted to change the configuration of a typical double glass facade to improve its performance.

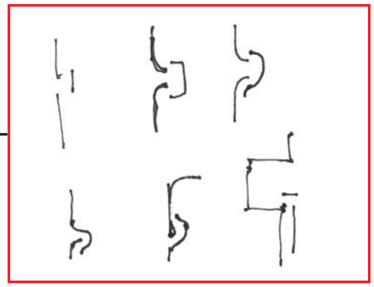
Ecology

Key Parameters of Double Glass Façade Properties

Key Parameters of Double Glass Facade Properties

- Ventilation rate in cavity
- Natural vs. mechanically assisted ventilation
- Single story vs. multiple story module
- Glass layer properties and sequence
- Cavity size and depth
- Shading device location, angle and properties

Since the reduction of heat gain is the main goal in most office buildings, it is always desirable to have the cool air come into the lower inlet and remove the hot air that is accumulated inside the cavity from the upper outlet. This air exchanging pattern that happens naturally is called stack effect.



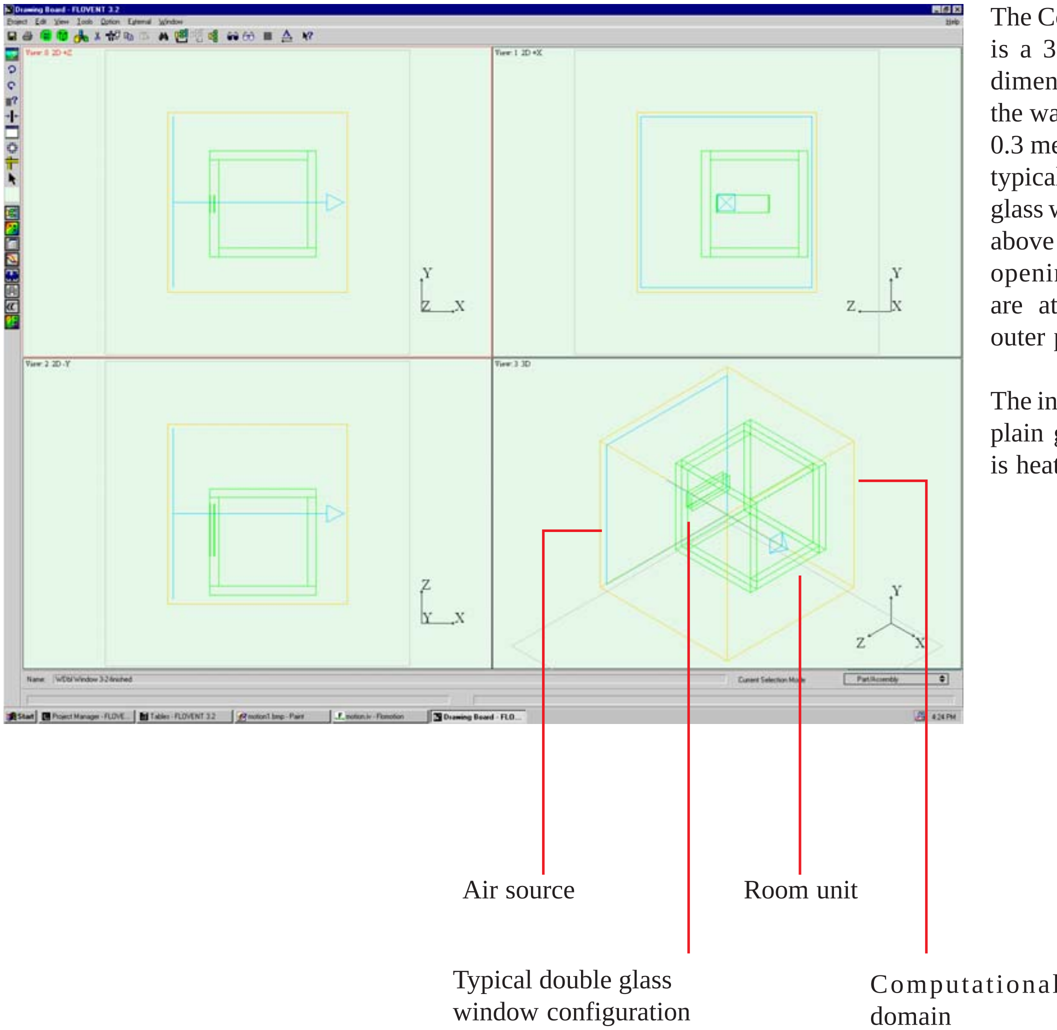
Schematic proposal:
Ventilation accelerator

Most double glass facades use the default inlet and outlet design. So the heat removal rate only depends on stack effect, but a simple design modification may change the heat removal rate by introducing different pressures to the inlet and outlet.

Computational fluid dynamic (CFD) software simulates air flow, temperature distribution and other fluid qualities. It divides space into small cubic units, simulating physical performance of air by applying mathematical models. It is an ideal tool to study the performance of double glass facades and can look into the detailed air flow performance which may not be done economically in a physical experimental setup.

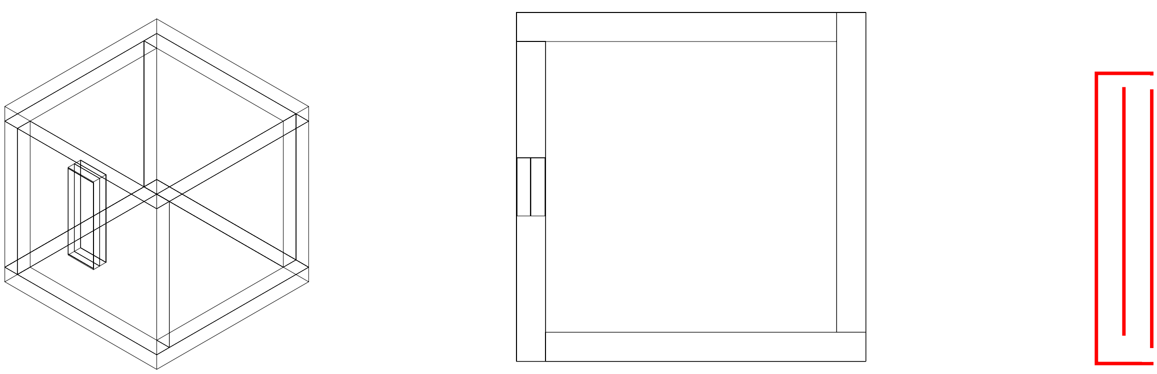
Task1 Computational fluid dynamics models will be developed.
Task2 Comparison of different system configurations using CFD

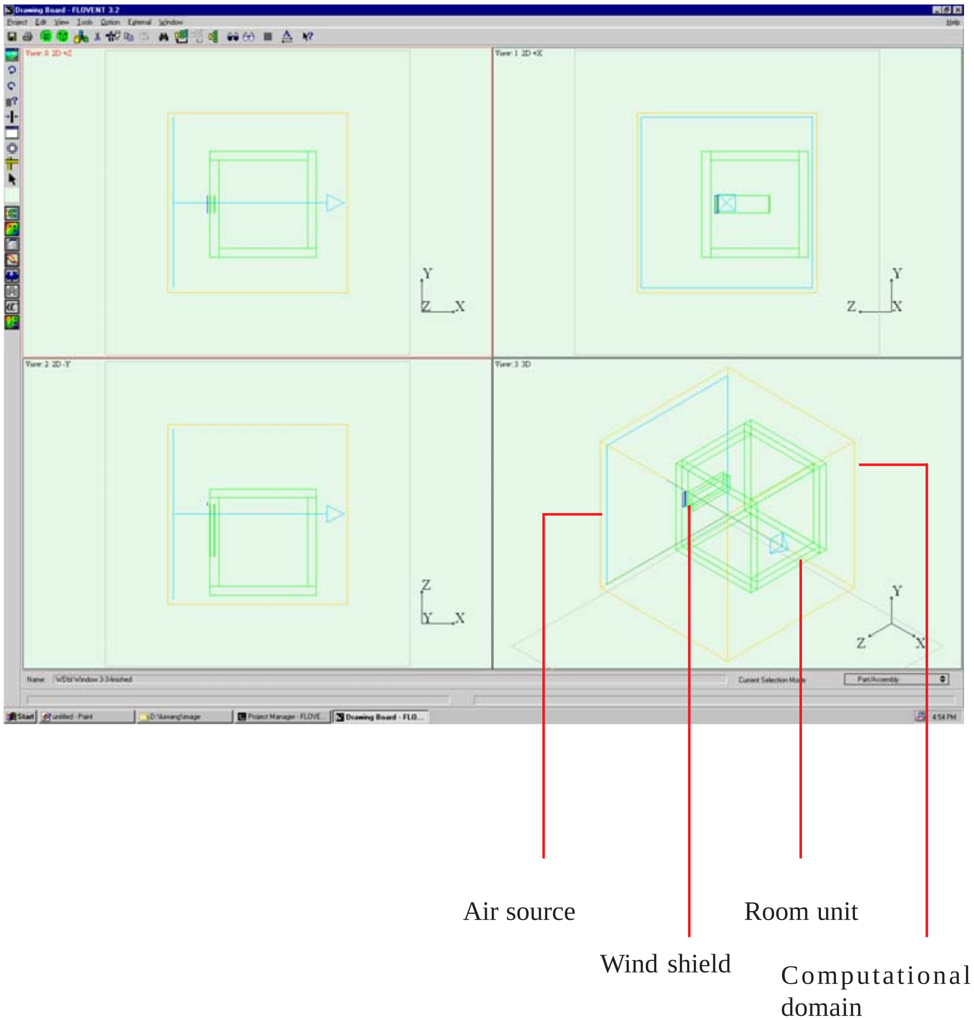
The purpose of this CFD simulation is to compare Ventilation Rate and Temperature Distribution between a typical double glass unit without wind shield and one with a wind shield over the outlet.



The Control Model is a 3x3x3 meter (interior dimension, the thickness of the wall and roof and floor is 0.3 meter) cubic room with a typical 0.6x1.8 meter double glass window located 1 meter above the interior floor. Two openings (0.02x0.6 meter) are at the bottom and top of outer pane.

The inner and outer panes are plain glass, the middle pane is heat absorbing glass.

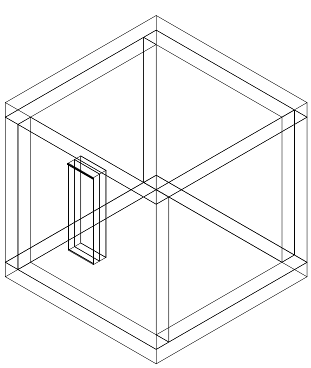


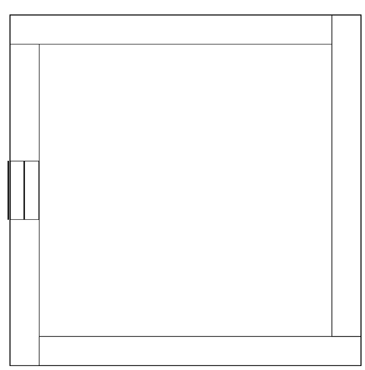


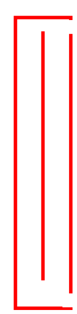
The Model with the wind shield is a 3x3x3 meter (interior dimension, the thickness of the wall and roof and floor is 0.3 meter) cubic room with a typical 0.6x1.8 meter double glass window located 1 meter above the interior floor. Two openings (0.02x0.6 meter) are at the bottom and top of outer pane. There is an additional piece of glass (0.6x0.02x0.005 meter) 0.02 meter in front of the top opening.

The inner and outer panes are plain glass, the middle pane is heat absorbing glass.

The wind shields also give the double glass facade a three dimensional quality *(see page 19 and 27)*.







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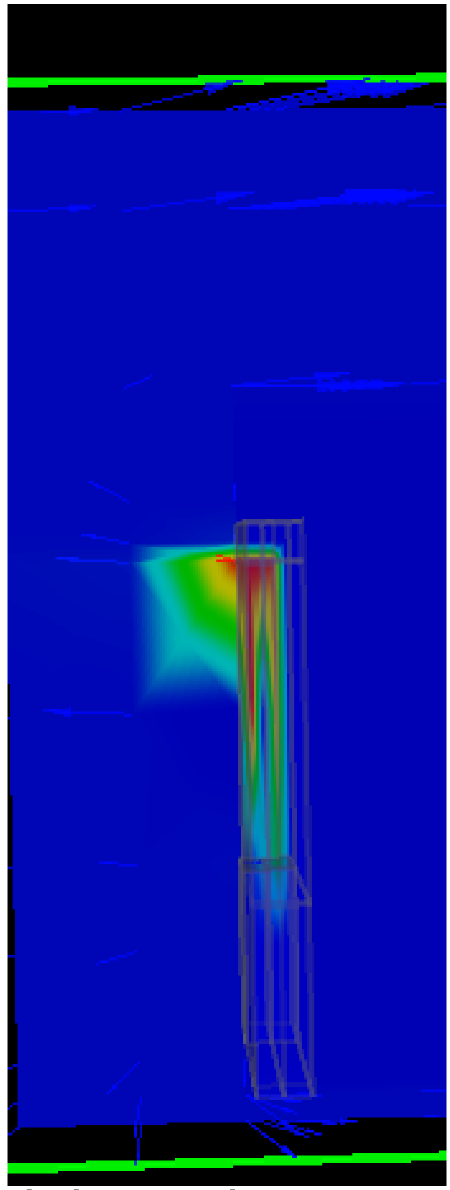
CFD - Conclusion

Higher temperatures and a larger range of higher temperatures are found in a typical double glass window when compared with a double glass window with a wind shield. This means that a wind shield can help increase the heat removal rate in the cavity. The direction of the high temperature zone also shows that a wind shield helps to accelerate the heat removal rate in the cavity.



The above image shows temperature distribution accoss the section of a typical DGF window, where the red color represents higher temperature and the green colore represents lower temperature.