LOW COST SOLUTIONS TO INSULATING YOUR HOME'S WINDOWS

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ABSTRACT

The research in this case study investigated the reduction of heat loss by various materials in window treatments. The apartment that was chosen to be researched is 30-40% glazed, thus the research in this case study is an analysis of the efficiency of different materials in keeping in heat so as to curb the 5 degree temperature drop over the course of one day. The materials that were looked at in this study are a thin sheer fabric, white felt, black felt and reflective space blankets. After installing each fabric for one day, HOBOs gathered temperature data on the inside of the apartment and out. Ultimately, the analysis showed that the black felt performed the best and the sheer fabric, the worst. The thickness of the black felt as well as its light absorbent property kept all heat in throughout the day and in fact gained by one degree. The sheer fabric lost all heat and the analysis showed a clear 5 degree temperature loss.

INTRODUCTION

The space that has been selected for this case study is the living room of an apartment on 1312 Mill St. This house was built around the turn of the century and sectioned into 12 single bedroom/studio apartments connected by a central staircase. The kitchens still have remnants of the old iceboxes used for refrigeration and the top floor apartments have unusable fireplaces. The apartment that has been chosen to study is on the third floor facing the Southeast corner.

The walls in this apartment are not well insulated, but the addition of new double paned windows in the summer of 2008, and its location on the third floor makes the living room a fairly comfortable temperature in the winter. The summer months can be incredibly hot but the operable windows on two sides create good cross ventilation. The living room is rectangular with windows covering the south and east walls which we believe makes the space cool rapidly during the night and heat quickly if the sun is out. There are no shading devices on any of the windows except for a short overhang that creates little to no blocking of the sun.

This is the only apartment in the entire building without curtains. These may be used for privacy or for heat retention. By testing materials with different thicknesses and colors the results may explain if curtains would retain the heat that may be lost during the winter months.

HYPOTHESIS

By adding drapes to all windows in a room that is 35% glazed, the temperature drop at night may be reduced by at least 5ºF.

METHODOLOGY

Overview
To determine how and if hanging materials over windows reduces heat loss, a set of experimentations have been laid out. This case study used materials of different thickness, emissivity, reflectance and opacity levels to see how heat loss could be reduced more efficiently and effectively.

Materials
One controlled environment:
- 13th and Mill, 3rd floor, Apartment 9, living room with east and south facing windows

Hobos, temperature devices:
- Three placed interior of controlled environment
- Two placed exterior of controlled environment

Cover Materials:
- One black felt curtain to cover windows
- One white felt curtain to cover windows
- One shear white curtain to cover windows
- One space blanket reflective curtain to cover windows

Process
1) Place HOBOs on the interior and exterior of a controlled environment to measure existing temperatures for at least three days and nights to get an average base indoor and outdoor temperature. HOBOs should hang from a eye level height to read a general air temperature rather than a surface temperature. Place one HOBO on the exterior side of east and south windows. Place one HOBO on the interior side of east and south windows, roughly three feet from window.
2) Heat room by 5F.
3) Hang one type of drape covering all windows in room at a time. Measure the interior and exterior temperatures with HOBOs for one day and night to get an average interior and exterior temperature.
4) With additional time, measure each drape for additional days to reach a more average temperature.

DATA AND ANALYSIS

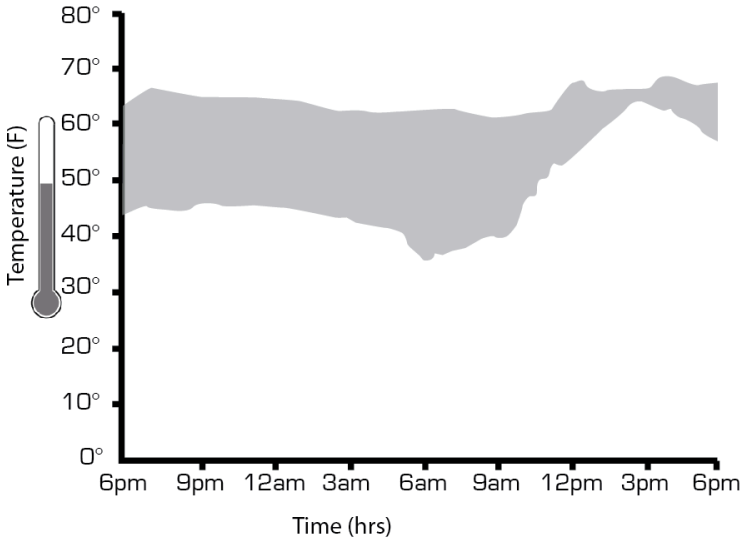


Fig. 1 Data gathered on a day without any covering over the windows.

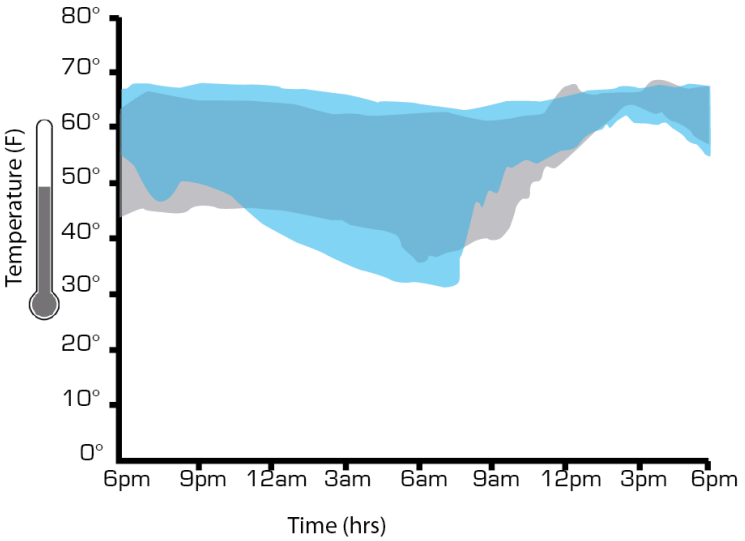


Fig. 2 Windows covered by black felt

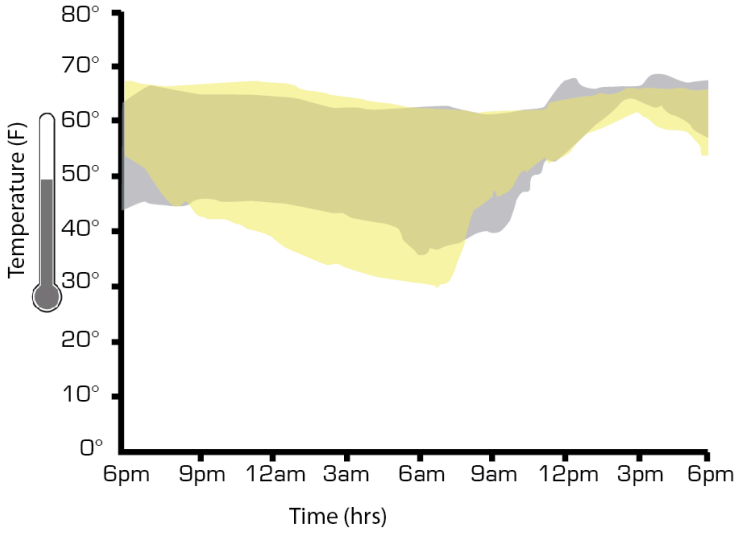


Fig. 3 Windows covered with white felt

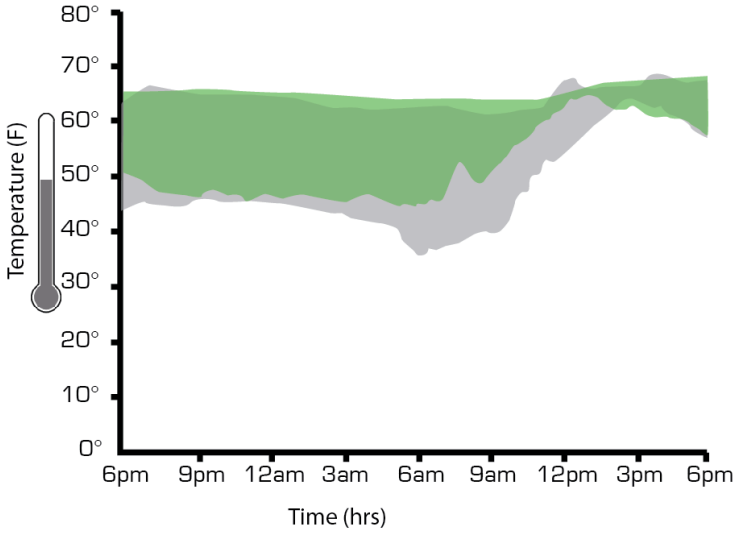


Fig. 4 Windows covered with space blankets

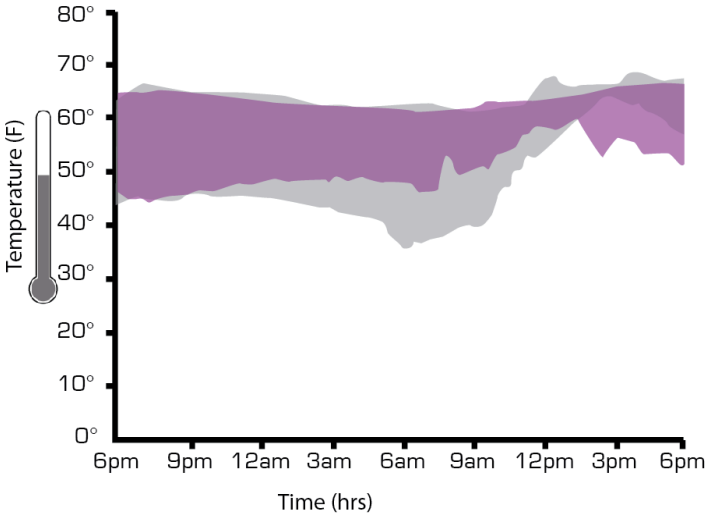


Fig. 5 Windows covered with sheer fabric

The black felt appeared to perform the best among all the fabric choices we considered. Even when the outside temperature dipped well below the control day the inside temperature stayed a comfortable temperature. We believe that this is because the black color felt's emissivity was higher than the lighter colored fabrics. This means it held in the rooms heat for a longer period of time.

The white felt performed well, but not up to the same standards as the black felt. Since the white felt was not holding as much heat, we determined that color was the only variable that contributed to the results. We also noticed that the felt materials caused a more even temperature regulation inside the room compared to the control day. Since both black and white felt performed better than any other method, we determined that thickness of material contributes to thermal insulation
We thought the space blanket material would perform the best among all materials because of its heat reflecting qualities. We were surprised with the results compared to the felt because it did not perform as well. We believe that the results may be caused by the space blanket reflecting the heat back outside instead of bringing it in the room.

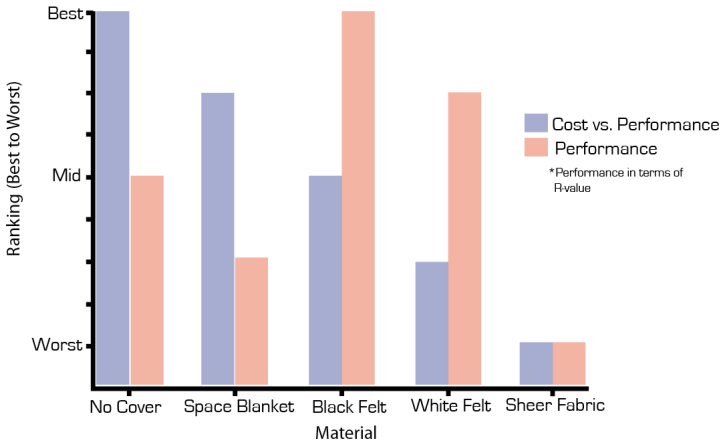
For the sheer material, we noticed that even though the outside temperature was warmer, but the indoor temperature was lower than the control day. These results are shocking and seem to defy common sense. We determined that sheer fabric would be efficient during summer months with high outside temperatures.

CONCLUSIONS

Once the data observations and analysis for the black and white felt were completed, assumptions regarding heat loss could be drawn. When the windows were left without cover, the interior temperature would very gradually decrease after 1 am. This gradual change, about 3-4 degrees Fahrenheit, would continue until about 10 am. For the most part, the indoor temperature stayed relatively constant, about 65 degrees Fahrenheit.

Once the felt covers were added, the temperature inside fluctuated very similarly to when there was no cover. On both nights, the out-

door air temperature dropped to 30 degrees Fahrenheit. The coldest the room temperature reached at that time was 61 degrees Fahrenheit. Based on our findings, we determined that the best performing material was the black felt, which could retain heat by 3 to 4ºF. The sheer fabric and space blanket seemed to have reverse effects, that performed even worse than the control day without any window covering. On a cost versus performance comparison based on calculated R-values, no covering is the best deal, yet if there needs to be cover, the most frugal purchase would be the space blanket.



Rank of Performance (in terms of R-value)	
BLACK FELT	12.5
WHITE FELT	12.4
NO COVER	11.3
SPACE BLANKET	8
SHEER FABRIC	7.2

Rank in Terms of Best Value ($/R-value [smallest ratio = best]	
NO COVER	0
SPACE BLANKET	1.75
BLACK FELT	2.6
WHITE FELT	2.6
SHEER FABRIC	3.6

For a more precise and in-depth study, a more controlled environment would produce more accurate results such as if the outside temperature remained constant. We pursue materials with a darker color because the fabric hue brought best results.

DESIGN LESSONS LEARNED

One major design lesson learned through this case study has been how to find an efficient way of preventing heat loss in a space through efficient materials. By using a material that is efficient, energy does not necessarily even have to be used as the heat can be retained by the window treatment. What has also been learned as a by-product of this research has been how to analyze temperature data from the HOBO equipment. These tools and subjects of research can be used for future studio projects.