OCCUPANT INTERACTION WITH VENTILATION SYSTEMS

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HOUSEHOLDER RESPONSE TO AIRTIGHTNESS INFORMATION

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SYNOPSIS

20 low-income family houses were studied for Air Changes per Hour and Equivalent Leakage Area as measured by the Blower Door Test during the winter of 1985-86. The residents of 10 of these homes were given instruction on air sealing techniques and were provided a "starter kit" of retrofit materials. Upon retesting, these 10 homes showed no improvement in either ACH or ELA, indicating either a lack of interest on the part of the householders in making their homes more airtight, or an inability to do so based upon insufficient information or physical limitations.

INTRODUCTION

Although the procedures and materials for air sealing of both new and existing homes is well documented, it is not clear to what extent occupants of older homes will implement retrofit techniques. Ball State University (BSU) in Muncie, Indiana, USA, through its Center for Energy Research/ Education/Service (CERES), has been furnishing a Blower Door test to homeowners which has provided ACH, ELA, a list of leak sites, and a prioritized list of procedures for cost-effective air tightening retrofit measures.

Some clients of BSU CERES have been governmental agencies which deal with housing for low income families. The occupants of such houses receive subsidies for heat or have had their homes rehabilitated through community funds.

Occupants of homes which have been tested as part of funded projects have not indicated that they would enthusiastically implement air sealing techniques. Since many of them receive governmental assistance in paying energy bills, they do not have a strong incentive to conserve energy.

To determine if governmental agencies have been spending money in the wisest manner, this study attempted to measure occupant response to information regarding the airtightness of their homes. This project was funded by a small grant from the BSU Office of Research to David Valentine, a junior majoring in Industrial Education and supervised by James J. Kirkwood, Ph.D., Professor of Industry and Technology.

LIMITATIONS OF THE STUDY

ACH or ELA were the only variables under study. Any significant changes in ACH or ELA would reflect occupant response to the experimental condition. Such response would include heightened awareness of air infiltration, attitude change, money spent on sealing materials and would provide an indication of the effectiveness of the instruction in air sealing techniques. No attempt was made to study the specific influence of these responses.

PROBLEM STATEMENT

The problem under study was to determine the effectiveness of a simple education program which entails providing householders with specific advice for tightening their homes and a "starter kit" of low cost-no cost sealing materials. As measured by a before-and-after blower door test, this program documented the impact of air leakage information and the occupants' initiative in retrofitting their homes.

GOALS

The goals of the research were to:

1. Define common problems associated with low-income housing in the community of Muncie, Indiana which experiences about 5500 heating degree days each year.

2. Enhance awareness of the need for energy conservation among the participants of the survey.

3. Supply information to City/State heat assistance programs so they may work out an education program for heat assistance program recipients.

4. Build a data base of commonalities of air leakage in Muncie's low-income housing.

5. Improve living conditions for some of Muncie's low-income families.

HYPOTHESIS

The hypothesis tested was: "There will be a significant difference between pre and post blower door tests in ACH and ELA in favor of the experimental group of houses."

Analysis of covariance was used to test the hypothesis. Satatistical differences are accepted at the .05 level of confidence.

PROCEDURE

The research design is a randomized Pretest-Postest Control Group Design. (Campbell and Stanley, 1967)

The population consisted of all houses in Muncie inhabited by families applying for heat assistance funds through the Muncie Housing Rehabilitation Program. The sample was obtained by assigning consecutive numbers to an existing list of applicants on file in the Muncie Housing office. Using a table of random numbers, 20 homes were selected for testing and were alternatively assigned to either the experimental or control conditions.

The investigator was given every assistance by the Muncie Housing Authority. Initial contact for each house was made by the Housing Authority. The investigator was identified as a representative of both the Housing Authority and Ball State University.

Data gathering took place during the Autumn and Winter Quarter, (September, 1985 through February, 1986). Each experimental house was tested with a Blower Door made by Infiltec of Falls Church, VA. The investigator presented the householder with a handout describing the blower door test and explained what was meant by ACH and ELA. The figures for ACH and ELA were collected and the house was investigated for leak sites with the home occupant in close attendance. During the test the householder was shown the leak sites and told how to seal them. Depending on the types of leakage found, the homeowner was given appropriate equipment (such as a caulking gun) and supplies (such as silicone or latex caulk, insulation, door and window weatherstripping, and electrical outlet gaskets), and given directions for proper installation. These materials were brought to the house 3 or 4 days after the test. The approximate value of such materials was $20 per house. Occupants were told that although there were not enough materials supplied to do the entire house, such supplies were inexpensive and would pay for themselves within one heating season.

One of the 10 houses in the experimental group was not retested due to occupant reluctance to admit the investigator upon his return.

The control group of houses was simply tested to yield ACH and ELA. This group was used to control for threats to internal and external validity. Although householders were always present during these tests, leak sites were not investigated nor reported to the occupant. Upon retesting, occupants were informed of major leak sites and were given instructions as to proper sealing techniques.

Each experimental and control house was retested four to six weeks after the initial test to determine any changes in ACH and ELA.

RESULTS

EXPERIMENTAL GROUP

	ACH		ELA (Sq. Ft.)	
HOUSEHOLDER	PRE TEST	POST TEST	PRE TEST	POST TEST
SHABAZZ	23.21	22.98	2.051	2.216
SIMS	27.94	29.05	2.539	2.914
KATES	46.43	46.45	4.377	4.417
BRITTAIN	21.65	21.54	2.294	2.293
ATHALONE	30.16	32.03	3.171	3.540
CORN	40.88	47.90	4.339	3.456
SWARTZ	18.00	19.97	3.951	4.961
RASCHE	11.79	12.33	1.437	1.582
COLE	10.97	15.99	0.787	1.927
total	231.03	248.24	24.946	27.306
mean	25.67	27.69	2.772	3.034

TABLE ONE RAW DATA FOR EXPERIMENTAL GROUP

CONTROL GROUP

	ACH		ELA (Sq. Ft.)	
HOUSEHOLDER	PRE TEST	POST TEST	PRE TEST	POST TEST
BUCKNER	17.00	17.10	3.264	3.370
EDWARDS	29.41	30.06	3.624	3.830
ODELL	42.51	41.88	3.551	3.530
JACKSON	23.93	23.83	3.851	3.841
McNEILL	26.37	27.32	2.746	3.142
ORR	46.36	46.22	4.355	4.352
BOYLE	16.08	16.36	2.119	2.200
BURTLEY	25.77	25.76	3.276	3.351
THOMAS	23.70	23.31	1.735	1.635
WYATT	24.68	24.13	2.610	1.675
total	275.81	275.97	34.131	30.926
mean	27.58	27.60	3.413	3.093

TABLE TWO RAW DATA FOR THE CONTROL GROUP

ANALYSIS OF COVARIANCE

SOURCE OF VARIATION	SUM OF SQUARES	DF	F
COVARIATES			
ACH PRE-	2044.935	1	619.8875
MAIN EFFECTS			
GROUP	17.055	1	5.169929*

*Significant at the .05 level

TABLE THREE ANALYSIS OF COVARIANCE
ACH POST TEST BY GROUP WITH ACH PRE TEST

SOURCE OF VARIATION	SUM OF SQUARES	DF	F
COVARIATES			
ELA PRE-	14.665	1	64.13764
MAIN EFFECTS			
GROUP	0.278	1	1.214097

TABLE FOUR ANALYSIS OF COVARIANCE
ELA POST TEST BY GROUP WITH ELA PRE TEST

A significant difference was observed as an increase of post test ACH for the experimental group as compared to the increase of post test ACH for the control group. ELA changes were not significantly different at the .05 level.

DISCUSSION AND CONCLUSIONS

There was a significant difference in the post test scores for ACH as compated to the control group, indicating that the experimental group of houses showed an increase of leakiness between pre and post testing. This difference was not found in the ELA data. The difference is probably atrributable to errors in measurement.

To avoid such errors in future testing it is suggested that leak sites be investigated in the post test as well as in the pre-test so that forgotten areas of leakage such as an open basement window will be closed as in the pre test. Further, the second test should be conducted under winter weather conditions, similar to the pre test.

The goal of the research to define common problems associated with low income houses (Goal 1) was unexpectedly achieved by finding that there was no improvement in the airtightness of these homes after the occupants were provided information and materials to effect such improvement. The sociological nature of the study was exploratory, opening more questions than providing answers. Goal 2, to enhance awareness of the need for energy conservation among the participants of the survey was not met, nor was Goal 3, to improve the living conditions of the participants.

At the time of testing, most occupants expressed a strong interest in making their homes more energy efficient. However, many of the occupants were infirm due either to a physical handicap or old age. These people indicated that they would have some family member or acquaintance do the necessary retrofit work.

The majority of the houses had already been subjected to some retrofit work to improve the quality of the home. Much of this work was done in the name of "energy efficiency," as insulation had been added and larger cracks had been sealed. Many of the homes had new windows installed. These windows were of poor quality and were not sealed tightly. A casual observation of the investigator was that the houses which had been worked on by city-hired contractors were not any more air tight than those which had yet to be retrofitted.

Major leak sites tended to be at the windows and doors of the houses. The windows did not fit or seal properly and doors had warped and did not fit their frames. The windows and front doors were a problem in all 9 experimental houses. The rear doors were a problem in 8 of the 9. Since one of the goals (goal 4) was to build a data base of commonalities of air leakage in Muncie's low income housing, the following list is a beginning.

Other leak sites included the following:

Electrical outlets/switches: 7 houses
Heat vents/ducts: 6 houses
Floor (Trim, cracks, holes): 5 houses
Plumbing stack: 4 houses
Cracks or holes in walls: 4 houses
Attic door: 3 houses
Basement: 2 houses
Ceiling fan: 2 houses
Kitchen base cabinets: 2 houses
Furnace: 2 houses
Clothes dryer vent: 2 houses
Air conditioner: 1 house

It is obvious that the occupants in this study did not act to improve the conditions of their homes. In some cases upon being visited for retesting, the "starter kit" of air sealing materials was still in the original container, showing that the materials had never been used.

The length of time between the pre test and the post test was 4 to 6 weeks. This gave sufficient time for a motivated householder to make substantial improvement in the air tightness of the house. A longer time span would provide time for more people to initiate improvements in the building envelope. However, the testing should all occur during the winter months to measure actual user living patterns.

Since there was no improvement in air tightness as a result of the testing and instruction, it remains open to question as to whether air tightness information is reaching the average homeowner. Also open to question is whether such information is understood (as in the case of the householders in the experimental group) and whether other socio-economic factors are operating to influence the application of self-help measures in improving the quality of their homes. Further testing with a different population, perhaps with middle income families, would yield results that could provide some insight on the techniques most helpful in achieving homeowner information (Goal 3.)

The houses tested were much leakier than the average house in the city of Muncie, Indiana. These homes are in dire need of repair both structurally and cosmetically. If such repair were conducted by competent contractors and with sufficient funding, such structural and cosmetic repairs would serve to make the houses more energy efficient due to increased insulation and air tightness. If such repair were also conducted with a better understanding of energy conservation practices on the part of the contractor, the houses could easily and inexpensively be insulated and air sealed to achieve comfort and economy for the occupants.