PASSIVE SOLAR HOMES AND THEIR INTERIORS: HOMEOWNER ATTITUDES

by

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Chapter 1

INTRODUCTION

Prior to the Industrial Revolution man depended on the sun, wind, fire, plants and himself for survival. Shelters reflected an understanding of the elements of nature by being positioned to take advantage of the sun and block our the cold north winds. Since the development of petroleum fuels and the harnessing of electricity, man has done much less work for himself (The Royal Society, 1979, p. 1). He has isolated himself from the forces of nature and allowed machines and fuels to do the work. Because of the inevitable depletion of fossil fuels, mankind must once again develop a renewed understanding of the elements of nature and work on new patterns of responsibility (Anderson, 1973, p. 17).

Man has employed solar energy in different ways for thousands of years, dating back to the fifteenth century before Christ. The Egyptian ruler Amenkotep III supposedly possessed "sounding statues" that operated when the air in their base pedestals expanded after exposure to sunlight. His son, Aari Memnon, allegedly owned an artificial bird that would sing when sunlight fell on it (Cheremisinoff and Regino 1978, p. 1). During this period of history, the use of the sun's rays to distill liquids and dry agricultural products was common practice. In 212 B.C., the Greek Archimedes used solar energy to defend the harbor of Syracuse against the Roman fleet. "One version of the story maintains that Archimedes used a large hexagonal mirror to set fire to the ships of the invading Roman fleet while they were still a

bowshot's distance from shore" (Behrman, 1976, p. 33). In 77 A.D., the chronicler Pliny wrote of the Roman practice of using burning glasses to light fires and to cauterize wounds (Cheremisinoff and Regino, 1978, p. 2).

The first published account of solar energy use after the fall of the Roman Empire was recorded in 1615, when Salamon de Caux constructed a "solar engine" (Cheremisinoff and Regino, 1978, p. 1). The device, made of a glass lens, a frame, and a metal vessel containing water and air, produced a small water fountain when the air was heated during operation. In 1774, Joseph Priestly concentrated the rays of the sun onto mercuric oxide and collected the gas produced by the heating, thus discovering oxygen (Daniels, 1964, p. 8). At a Paris exhibition in 1878, solar energy was focused into a steamboiler which operated a steam engine that in turn powered a printing press (Daniels, 1964, p. 9).

The first significant boost to modern research in the use of solar energy came in the 1930's at the Massachusetts Institute of Technology (M.I.T.). Work there concentrated on the use of solar energy for heating buildings; the first solar heated house was built in 1939. In 1947, M.I.T. House II was built to test space heating by exposing a storage wall to the sun. This structure was remodeled in 1948 and became M.I.T. House III, which was successfully heated by solar energy for several years. M.I.T. House IV was built in 1959 and focused on summer cooling and solar heated hot water. Complications and commercially noncompetitive results led to the termination of M.I.T.'s efforts (Anderson, 1976, p. 8).

In the 1950's G.O.G. Lof completed two houses and explored hot air collection, mass produced collectors, and crushed rock heat storage. Harry Thomason, in the 1960's, developed four solar heated houses resulting

in low-cost collectors, simplification of design, and long term heat storage. At least 25 other solar heating and cooling projects were built prior to 1965 (Anderson, 1976, p. 8).

Since the emergence of the first modern fuel crisis in the early 1970's, research in solar energy has exploded. Many projects have been completed and hundreds more are on the drawing boards. Before 1974 there were virtually no commercially available solar collectors for the heating and cooling of buildings. Presently at least 200 manufacturers are marketing their products (Anderson, 1976, p. 8).

Until recently, many researchers saw the use of solar energy in a very narrow context, focusing only on the thermal properties and responses of the system. During the past few years, however, there has been a vigorous renewal of interest among social scientists in the relationship between human behavior, attitudes, and the physical environment. "There has been a major shift within the architectural profession, and in the schools of architecture in the United States, which reflects the general concern for social issues that has pervaded all the professions since the 1960's" (Conway, 1973, p. 1-3). There is an increasing interest in broadening the scope of architecture to include both ecological and social concerns.

An important focus of this concern is an examination of owner attitudes and interaction with their systems. According to Bruce Anderson, (1976)

> ...to use solar energy we must do a lot more than simply tack a collector onto a house and judge success by fossil fuel savings. One of the first changes in attitude must be toward our greedy consumption of resources. Another change will be in our attitude toward the interface between home/shelter and nature. Owner/user

> participation may take advantage of what nature has to offer. Instead we will to a greater extent, participate in the life functions that support our existence (p. 12).

Frank Lloyd Wright said design is an "art with a purpose." In the past few years these words have taken on a special meaning. There is a growing belief in two interrelated ideas: "(1) The designed environment affects the human experience in direct and important ways. It does not determine experience, yet in combination with social influences, designed environments can support satisfaction, happiness, and effectiveness. (2) Despite their potential, designed environments often do not work with respect to their impact on human experience. They are awkward, even destructive, rather than being supportive of personal competence and growth" (Friedmann, Zimring, and Zube, 1978, p. 1).

The need for environmental design evaluation is gaining recognition within professional groups of behavioral scientists and designers. The social environment, and how it affects human behavior, has been studied by social scientists but the role of the physical environment has been neglected. The recent surge of interest has focused on behavioral research and the role of the designed environment.

William H. Whyte commented on the "failure of designers to observe the consequences of their actions and to systematically learn from past experiences. A number of authors have discussed the failure of design professionals to consider evaluation as an essential stage in the design process" (Friedmann, Zimring, and Zube, 1978, pp. 3-4). The design process usually terminated with the construction of the project. The evaluation has the potential to be an effective educational device within the design profession. An evaluation of a completed project can

provide valuable information to educate students in design schools as well as updating established professionals.

In reviewing the literature, Friedmann, Zimring and Zube (1978) stated several reasons for the development of design evaluation programs:

(1) To increase the understanding of human behavior by documenting the transactions of people and the built environment.

(2) To include evaluation as one of the stages of the design process for fine-tuning existing environments and creating new ones.

(3) To provide an important body of data for use in the education and training of design students, as well as data for continuing education.

(4) To gather data for analysis of the impact that policies and programs, which support and constrain design, have on various environmental settings.

(5) To collect information to be used to predict user satisfaction and environmental fitness (pp. 5-6).

With an awareness for the need to develop design evaluation programs, the study proposed here will attempt to determine satisfaction, use, and extent of involvement with the home and solar features within the following areas:

(1) The homeowners involvement with the design and construction process of their homes.

(2) The direct involvement of the homeowner in the functioning of the home.

(3) The extent of involvement to optimize functioning

of the passive solar system in their home.

(4) The total performance of the passive solar features of the home.

(5) The use of rooms in a passive solar home.

(6) The interior design and its effects on the performance of the house.

Chapter 2

REVIEW OF LITERATURE

The base of information reviewed is divided into two categories: general background information on solar design and previous research on attitudes toward solar residences.

Background Information

Two approaches to the solar heating or cooling of buildings have been developed: active and passive. An active system requires external mechanical power to collect and move the heat. A passive system can collect and transport the heat by using nonmechanical means. The focus of this section will be on the various generic approaches to passive solar energy design.

There are two basic design features in every passive solar-heating system: south-facing glass for solar collection, and thermal mass for heat collection, storage, and distribution (Langley, 1978, p. 319). These interface to provide a system by which the total needs for heating energy can create a comfortable environment.

There are three approaches to passive solar design, they are: direct gain, indirect gain, and isolated gain. In the direct gain approach, "there is an expanse of south-facing glass, and enough thermal mass, strategically located in a space, for heat absorption and storage" (Mazria, 1979, p. 29). The sun angles result in a favorable situation, since the south face is exposed to a maximum amount of solar energy in the cold winter months when the sun angles are low. The solar energy

entering the building is stored for use at night. The walls and/or floors are made of a material suitable for the storage of heat. The most common materials used were a poured concrete floor, a massive masonry construction with insulation on the outside, or a water wall (Stromberg, 1977, p. 5).

In the indirect gain approach to solar heating, "there is a thermal mass which is located between the sun and the space. The sunlight absorbed by the mass is converted to thermal energy and then transferred into the living space" (Mazria, 1979, p. 43). Two types of indirect gain systems have been developed: the thermal storage wall in which the mass is situated in the wall, and the roof pond in which the mass is contained on the roof of the space being heated. The thermal storage wall is usually painted black to enhance absorption qualities and may consist of water in containers or a heavy masonry (trombe) wall. Where roof ponds are used, movable insulation is needed because sun angles cause large solar inputs in the summer and small inputs in the winter. This system allows for good natural cooling because the movable insulation enables one to take advantage of nighttime radiation (Stromberg, 1977, p. 5).

In the isolated gain approach to solar heating, "solar collection and thermal storage are isolated from the living spaces. This arrangement allowed the system to function independently of the building, with heat drawn from the system only when needed" (Mazria, 1977, p. 59). One application of this approach is the natural convection loop in which the components are a flat plate collector and a heat storage tank.

According to Anderson (1976), "a building that passively utilizes the energy of the sun for year round space conditioning involves three

basic principles:

(1) The design must be able to accept or reject solar heat when necessary and it must also let coolness in as needed.

(2) The building must have the thermal integrity to maintain internal comfort despite the range of climatic forces acting on it. It must store the heat for times when the sun is not shining.

(3) The design must have the ability to retain the presence or absence of heat within. It must make good use of the heat or coolness and let it escape only very slowly" (pp. 78-79).

These three principles work effectively when the solar gain surfaces are of the right size and are located in the appropriate place to effectively admit or reject natural heat. "Passive solar structures must be well insulated and must contain adequate heat storage mass. By the use of movable and flexible devices, the flow of energy can be controlled throughout the various conditions of all seasons" (Wright, 1978).

Previous Research on Attitudes Toward Solar Residences

A limited amount of research has been conducted on attitudes toward passive solar homes or on solar homes in general. Many of the studies cited in this section were included in Unseld and Crews" 1979 publication on the Solar Energy Research Institute. This work was titled Residential Solar Energy Users....A Review of Emperical Research and Related Literature. These research efforts were not reported elsewhere.

In 1976 Lorriman conducted a study entitled, "Perceptual Assessment Of A New Energy Concept" (Unseld and Crews, 1979, p. 39). It was unique in that it employed a user-owner assessment of life in

a solar home. He recorded his experiences for eight months and had friends and neighbors complete questionnaires giving their responses to the interior and exterior appearance of his house. The majority of the reactions were positive; however, overall feelings were expressed that the north face of the house was uninteresting due to the lack of windows. The respondents felt that the interior lacked sufficient light and was too small. There was a general feeling that the house had good resale value due to the solar design, the high insulation values, and the high quality of construction. Negative feelings focused on the complicated solar system, the high initial cost, and the size of the house.

Lorriman noted a problem with excessive heat gain from the large amount of glass on the south face of the house. During the winter months glare was a problem which was solved by rearranging the furniture facing away from the sun. He also experienced problems with reflection from the collector panels. During the summer the reflection irritated people using the backyard. Despite the existing problems Lorriman was very enthusiastic about his house. He also reported an increased awareness of the weather.

During 1976-1977 Hamrin investigated, "Low Energy Consuming Communities: Implications for Public Policy" (Unseld and Crews, 1979, p. 9). The sample consisted of an experimental group of solar users, and a control group owning conventional homes in neighboring subdivisions in California. Personal interviews were used to gather the data. The characteristics of the experimental group were consistent with Rogers' (1962) description of innovators as younger and having a more favorable financial position and social status (p. 172). The people selecting the experimental housing had fewer children, wanted greater

self-sufficiency, and were willing to make some behavioral and lifestyle changes. They did not exhibit conservative behavior as strongly as that of individuals in conventional housing. They felt that they had made their contribution to energy conservation by buying a solar home. There appeared to be greater acceptance of innovative housing designs in a subdivision of similar designs rather than in a setting with conventional homes. Homeowners in the experimental group used significantly less total energy than did the control group.

During May and June of 1977 a study entitled, "Solar Consumer: An Investigation Toward Commercialization" by Cook, Conelly, and Garret was undertaken in Arizona (Unseld and Crews, 1979, p. 20). A convenience sample of 26 solar consumers was personally interviewed. The following constitute an overview of the conclusions drawn by the researchers. The respondents were mostly middle-aged, conservative professionals, characterized by a practical outlook on life, high achievement motivation, the ability to make independent judgments, and the resources to purchase a solar home. Before purchasing the respondents sought information from other solar users. Most were satisfied with their solar systems and stated that strong economic motivation was a force relative to adoption.

From September, 1977, to September, 1978, Yarosh and Litak focused their research on "Solar Commercialization: The Consumer Experience" (Unseld and Crews, 1979, p. 37). Approximately 800 solar users in Florida were telephoned, visited, and filled out questionnaires. The sample surveyed was very committed to solar design, and very satisfied with their solar systems. During site visits there were indications that a discrepancy existed between the levels of satisfaction, as

expressed in the questionnaire, and the actual working conditions of the solar systems.

Beginning in October, 1977, and ending in April, 1978, Sawyer conducted a study entitled, "A Survey of Solar Consumers in Northeastern and Southwestern United States" (Unseld and Crews, 1978, p. 22). The sample consisted of 177 solar users, 88 in New England and 89 in the Southwest. Face-to-face interviews were conducted; the major findings included: 84% of the solar users were satisfied with their systems; "this satisfaction did not appear to be related only to financial savings but to the expectations of the functioning of the system" (Unseld and Crews, 1979, p. 22). Sawyer reported that the solar consumer was strongly motivated by economic and environmental concerns, as well as a desire for greater self-sufficiency.

In 1978, the Subcommittee On Oversight and Investigation investigated "Solar Energy and Today's Consumer" (Unseld and Crews, 1979, p. 27). The study sites were located in California, Michigan and Wisconsin, with a sample size of 336 solar users. The data were collected by a mailed questionnaire with the following results. A high level of satisfaction (86%) with the solar systems may have resulted because of the large number of do-it-yourselfers in the sample. The types of satisfaction were in the areas of money being saved, energy conservation for the nation, and in the contribution toward a cleaner environment. Sixty-four percent of the sample reported that owning solar equipment had not been troublesome, with the remainder reporting problems with maintenance, locating reliable equipment and installation. Information on solar equipment was most often found through solar dealers, magazine or journal articles, solar fairs or exhibits, or friends and

neighbors. Over half of the respondents calculated payback periods for their system, with 31% of those who made calculations estimating a 2-5 year payback period and 38% a 5-10 year payback period. Sixty-two percent of the sample reported savings in utility costs.

In the spring of 1978 Leonard-Barton studied, "The Diffusion And Adoption Of Solar Equipment Among California Homeowners: Report on a Pretest Study" (Unseld and Crews, 1979, p. 14). This research took place in California with a sample of 25 (19 were solar users; 6 were in the process of acquiring a solar system). Personal interviews were conducted and the following results were reported by the researcher. The majority of the sample were young, wealthy professionals with families. Primary considerations in their decision to adopt solar technology were environmental and conservation concerns, such as easing the energy shortage and a lack of harmful effects on the environment. Other considerations were the initial cost of the system, not having to pay monthly energy bills, reliability of the system, and a possible increase in the resale value of the house. Twenty-four of the twenty-six respondents were satisfied with their solar system and indicated they would install solar equipment in a new home in the future.

The Marylander Marketing Research Incorporated, in 1978, initiated a study entitled "San Diego Gas and Electric Solar Water Heating Initial Purchaser Analysis" (Unseld and Crews, 1979, p. 17). Eighty-nine telephone interviews were conducted (17 purchasers and 72 nonpurchasers). A motivating factor for interest for nonpurchasers as well as purchasers was the cost-saving aspects of a solar system. Purchasers were likely to mention conservation also as an important factor. The major benefit perceived by both groups was the financial savings. Seventeen of the

purchasers were generally satisfied with their solar systems; however seven negative comments were made about the solar hot water systems. Purchasers reported positive reactions to their solar hot water heaters by their neighbors.

In March of 1979, Wilson conducted a research study, entitled, "Missouri Solar Consumer Survey" (Unseld and Crews, 1979, p. 33). Face-to-face interviews were conducted with 75 solar users. The following results were reported by the researchers: sources of satisfaction for the consumer were monetary benefits and effectiveness of the system. The major sources of dissatisfaction were those associated with installation and mechanical difficulties. Many people felt that the energy situation was serious and were involved in other energy conservation activities outside of their solar homes. The respondents reported feelings of pride in ownership and stated that other people's reactions were favorable. Respondents complained that sources of information on solar equipment and design were scarce. Information was difficult to locate and was sought through individuals, books, and magazine articles.

In September of 1980, the Solar Energy Research Institute mailed survey forms to 3,800 solar homeowners (Pilgrim, 1981, pp. 29-31). The respondents expressed their concerns about performance, problem areas, costs, their motivations, and degree of satisfaction. The majority of the sample were owners of a domestic hot water system. Wood stoves and passive solar designs were the second and third most owned systems. Many felt their systems were in good to excellent condition. Many homeowners had experienced no problems with their solar systems. When problems occurred they were associated with maintenance, installation, evaluation, and the location of clear, reliable information on solar

systems. Eighty-nine percent were satisfied with their experiences as solar homeowners. Warranty coverage, initial cost, operating reliability, and the dependability of the solar firm were the perceived risks by the homeowner. The most important advantages were: protection against rising energy costs, saving money over the long run, reducing current utility bills, increasing overall self-reliance, easing the energy shortage, conserving natural resources, and having a more reliable supply of energy. Two-thirds of the solar homeowners expected to save from 10-50% on their utility bills each month as a result of their solar systems. A large percentage of homeowners calculated their own estimates of possible savings, others relied on information from builders, books and magazines, and the distributors of the systems.

During October and November of 1980, the Solar Energy Research Institute commissioned the Gallup Organization to conduct a study of 2,023 homeowners (Pilgrim, 1981, pp. 22-26). Through personal interviews conventional homeowners' attitudes about solar energy were determined. Factors that would convince them to use solar as a source of energy were also ascertained. These homeowners made a few adjustments in their lifestyle due to the current energy situation but they did not consider these adjustments serious. Fifty-three percent of those interviewed believed the national energy situation will improve and 27% believed that it will get worse. Homeowners strongly preferred solar energy over other energy alternatives, but a majority still viewed solar energy as a future technology rather than one for the present. Seventy-seven percent of the homeowners favored the use of solar energy in residences and viewed people who had solar energy systems as economy-minded, upper-income, scientific types, and as environmentalists. Fifty-seven percent

favored, and 20% opposed the use of solar energy for themselves at this time. Almost two-thirds of the homeowners had not considered investing in solar energy, while 18% were considering or planning on making the investment. Warranty coverage, initial cost, reliability, possible damage, and safety of solar energy systems were perceived as risks by the homeowners. The most important advantages were saving money in the long run, reducing present utility bills, protection against rising costs, having a more reliable source of energy, and conserving natural resources. The most frequently used sources of information on solar energy were people who had a solar system, model solar homes, books, journals, and reports about solar energy.

The concepts that have been discussed in the review of literature formed the basis for this research. Because of the limited amount of information available on attitudes toward passive solar homes or on solar homes in general, the research was of a descriptive nature.

Chapter 3

PROCEDURE

Purpose

The purpose of this research was to investigate homeowner rationale for, and feelings about, living in passive solar homes. Satisfaction, use, and extent of involvement with the home and solar features were determined. Demographic information was obtained to characterize the sample.

Objectives

The following objectives were important in this study:

(1) To determine the reasons individuals live in solar homes.

(2) To determine the means used by individuals to become informed about solar energy.

(3) To determine the extent of involvement of the homeowner with the functioning of the passive solar system.

(4) To determine the perceived performance of the passive solar features.

(5) To determine the extent of satisfaction with the general interior, exterior, and overall features of the passive solar home.

Limitations

The respondents participating in this study were limited to

passive solar homeowners in Richmond, Lexington, Roanoke, Blacksburg, and the Tidewater area in Virginia. The families residing in these homes may not be representative of all passive solar homeowners in the state of Virginia.

Constitutive Definitions

"A constitutive definition defines words or constructs by using other words, which is what a dictionary usually does" (Kerlinger, 1973, p. 30). The following constitutive definitions are essential in this study:

(1) Attitude - "a state of readiness; a tendency to act or react in a certain manner when confronted with certain stimuli" (Oppenheim, 1966).

(2) Interior - the inside part of a building, considered as a whole, including everything that is visible when the construction of the building is complete.

(3) Behavior setting - "a standing pattern of behavior that occurs over and over again in a given place and at a given time. You can go to the place where it occurs at the time it occurs and see the behavior repeated each time the setting happens" (Bechtel, 1977, p. 22).

(4) Passive solar design - a system that collects and transports heat by natural means. The building structure or some element of it is the system (Anderson, 1976, p. 14).

(5) Early adopter - local agent for speeding the diffusion process, they serve as a role model for many other members of the social system

(Rogers, 1974, p. 184).

Assumptions

The following assumptions were made during the course of this research:

(1) The population from which the sample is drawn has an upper educational background and is in the middle income brackets.

(2) The population from which the sample is drawn has a strong interest in passive solar energy designs.

(3) The population from which the sample is drawn will be considered early adopters for the purpose of this research.

The Instrument

A self-administered questionnaire was developed by faculty and graduate students from several different departments at Virginia Polytechnic Institute and State University: Clothing, Textiles, and Related Art; Psychology; and Architecture.

The questionnaire consisted of five sections with brief introductory statements. The first section focused on feelings about, and rationale for, living in a passive solar home. The second group of questions dealt with the design and function of the passive solar home. The next section of questions focused on the interior design and its effect on the performance of the house. The fourth group of questions assessed demographic factors; and also included a home profile to determine family activity patterns. The last section of

questions assessed other environmentally relevant practices of the participants.

Items incorporated in the first four parts of the questionnaire were used for this research. Items numbered one thru six and nine, focusing on feelings and rationale, were utilized from the first section. All the questions from the second group, dealing with the design and function of the home, were included. The third section dealt with the interior design of the home and was used in its entirety. Only items 33 and 34 were used from the last group of questions that ascertained demographic information about the respondents.

A cover sheet was attached to each of the questionnaires. On it the general purpose of the research was explained and the cooperation of the owners of passive solar homes was requested.

Sample Selection

It was intended to obtain a sample of 40 respondents from the owners of passive solar homes in Blacksburg, Lexington, Roanoke, Tidewater and Richmond, Virginia. Initial contact with the homeowners was made through a representative of the local chapter of The Virginia Solar Energy Association. Through this mechanism it was ascertained whether or not the homeowners would participate in the study. A total of 63 indicated interest, and questionnaires were distributed at the next scheduled meeting of each local chapter. After repeated attempts to obtain completed questionnaires it was decided to analyze the date from the 28 cooperating homeowners.

Data Collection

The Richmond, Roanoke, and Tidewater Chapters of the Virginia Solar Energy Association were contacted in an effort to secure information about life in a solar home. General information about the study was given and owners of passive solar homes who were interested in participating in the study were contacted. Those individuals attended a special meeting with a representative from Virginia Polytechnic Institute and State University. Each potential respondent was given a booklet explaining participation in the Virginia Passive Solar Study. In addition to an explanation the literature contained interesting graphic details that were attractive and designed to create motivation and interest in the homeowner.

Questionnaires were distributed at these meetings and each participant was provided with a stamped self-addressed envelope to return the data to the researcher. Owners of solar homes in Blacksburg were contacted through local sources. The opinionnaire, as well as a self-addressed envelope and postage, were hand delivered to these respondents.

Since the sample was somewhat limited in size every effort was made to guarantee a high rate of return. After a two week waiting period individuals to whom questionnaires were given were contacted by telephone, either to thank them for completion of the instrument or to remind them of their prior commitment. Assistance in completing the survey was offered. During the months of April, May and June 1982 repeated phone calls were made to these individuals to urge them to complete the survey instrument. In addition, a letter was sent reminding them that their completed questionnaire had not yet been received.

By the end of June it was determined that the 28 completed questionnaires which were returned would be sufficient for use in this research.

Data Analysis

Frequency and percentage distributions were calculated to describe the sample and characterize the findings from the study. With the assistance of a statistician it was decided that statistical analysis to determine relationships among the variables was not appropriate with the small sample size.

Chapter 4

FINDINGS AND DISCUSSION

Homeowner satisfaction, use, and extent of involvement with the passive solar home were investigated. In addition, demographic information was obtained to describe the sample. The major findings are discussed in five general sections: (1) background characteristics; (2) reasons for living in passive solar homes; (3) involvement with the home; (4) performance of rooms and solar features; and (5) satisfaction with the home and furnishings. While reading this chapter it should be kept in mind that the findings are based on information gathered from a limited sample of 28 owners of passive solar homes.

Background Characteristics

All subjects were asked to give background data concerning sex, age, income, and the total number of people residing in the home. An approximately equal number of adult males (52%) and females (48%) were present as well as 23 children. These youngsters were generally school aged with a fairly equal distribution between six and fourteen years. Ages of the adults ranged from 22 to 66 years. The major portion (40%) were between 30 and 39 years of age, followed by the 20 to 29 (27%) age group.

Yearly incomes average $20,000 and above. Almost two-thirds of the sample had incomes from $20,000 to $50,000. An additional 17% were represented in the $50,000 to 74,999 category and 7% in the $75,000 plus category (Table 1).

Table 1

Description of Respondents

Variable	No.	%
Sex		
Male	27	52
Female	25	48
Total	52	100
Age		
20-29	14	27
30-39	21	40
40-49	12	23
50-59	2	4
60-66	3	6
Income		
$20,000 - 34,999	9	32
$35,000 - 49,999	9	32
$50,000 - 74,999	5	17
$75,000 - plus	2	7

The characteristics of the sample are consistent with Rogers' (1962) description of innovators as younger and having a more favorable financial position. Leonard-Barton, as cited in Unseld and Crews (1978), also found that the majority of their owners were young, affluent professionals.

Twelve (43%) respondents lived in two member households and six (21%) in those with four people. This represents a total of 64% of the sample living in households of four or less. These findings are consistent with Hamrin, as noted in Unseld and Crews (1978), that a majority of people selecting experimental housing have a limited number of children.

Reasons For Living In Passive Solar Homes

Respondents were asked to check reasons for the selection of their homes and to note the sources of information that were used to aid in the decisions. The majority (96%) indicated that saving money on fuel was a major factor in their decision to live in passive solar homes. Cook, Conelly and Garret; Leonard; and Sawyer, referred to in Unseld and Crews (1978), found that this economic motivation was also a strong force relative to adoption of solar energy utilization for homes.

Twenty-three (82%) noted the feeling of sunlight and warmth and 22 (79%) were pleased with the design of their home. An ecology-minded group, many (75%) were interested in saving non-renewable natural resources (Table 2). These findings are similar to those of Leonard-Barton and Sawyer, cited in Unseld and Crews (1978), who determined that the owners of solar homes were interested in environmental

Table 2

Solar Homes as Residences

Solar Living	No.	%
Reasons for Living in Solar Home		
Save money on fuel	27	96
Save resources	21	75
Like the design	22	79
Best house available	4	14
Was an accident	0	0
Alternative energy idea	12	43
Feeling of sun/warmth	23	82
Others	7	25
Information Sources on Solar Energy Use		
NSHCICenter	4	14
Architect/builder	9	32
Friend/family	5	18
Personal research	24	86
School	5	18
Newspaper	24	86
Others	4	14

Table 2 (Continued)

Solar Living	No.	%
Information Sources on Solar Adaptations		
Library	8	29
Periodicals	18	64
Media	6	21
Consulting specialists	18	64
Community organizations	1	4
Other	8	29

and conservation concerns, such as easing the energy shortage and a lack of harmful effects on the environment. Unseld and Crews (1978) reported Wilson found many people felt the energy situation was serious and were involved in other energy conservation activities outside of their solar homes.

Twenty-four (86%) participants became informed about solar energy utilization through personal research and articles in magazines or newspapers. Others (64%) consulted specialists and periodicals concerning solar adaptations that would meet their needs. In a previous study cited by Unseld and Crews (1978), Cook, Conelly, and Garret determined that before purchasing a solar home the respondents sought information from other solar users (Table 2). Unseld and Crews (1978) reported that the Subcommittee On Oversight and Investigation had determined that information on solar equipment was most often found through solar equipment dealers, magazine articles, friends, and neighbors.

One-half (50%) of the respondents reported having no trouble locating information about solar adaptations to meet specific needs. Some trouble was encountered by 43% and a few noted difficulty in procuring literature. Unseld and Crews (1978) reported that Wilson found subjects complained that sources of information on solar equipment and designs were scarce, difficult to locate, and were sought through individuals, books, and magazine articles. Perhaps since some time has lapsed, information relevant to solar adaptations has become more readily available to the public.

Involvement With The Home

Respondents were asked to indicate how they acquired their solar

homes and how much direct involvement they had with the functioning of them. Slightly less than half (46%) had their homes custom built to specification, while 21% hired someone to design their home. Still others bought existing solar homes or modified other residences (Table 3).

One-half of the homeowners were mainly responsible for the building or modifications of their homes; while 43% had an architect involved in the process. Twelve (43%) reported the use of a builder (Table 3). The Subcommittee On Oversight and Investigation, as cited in Unseld and Crews (1978), reported 86% of the sample of solar users were do-it-yourselfers. These findings are an indication that many owners of solar homes are often involved in the building or modification process.

Owners were highly involved with the articulation of design features. More than two-thirds gave input into the selection of built-in features (75%), design of the floor plan (68%) and the selection of the building site (64%). Physical labor was contributed by almost half (43%) of the respondents (Table 3).

Of those homeowners who utilized the services of an architect, 94% felt that he was well-to-adequately informed on solar design, while 74% felt that the builder was well-to-adequately informed. Six (21%) respondents commented that the architect and/or builder had consulted other peer professionals in areas of design.

Participants were asked to rate the extent of involvement with the functioning of their homes. Ten (36%) reported an equal combination of automatic and occupant-controlled functioning. One (4%) home was totally automatic and six (21%) homes were totally occupant controlled (Table 4). When asked how they would prefer their homes to

Table 3

Design Considerations Relative to Owner Involvement

Design Considerations	No.	%
Acquisition of Solar Home		
House designed	6	21
Built to specification	13	46
Bought existing solar home	4	14
Modified existing home	3	11
Others	6	21
Construction/Modification		
Architect	12	43
Design/building firm	6	21
General contractor	12	43
Self	14	50
Others	5	18
Involvement With Design		
Physical labor	12	43
Design of floor plan	19	68
Selection of solar features	17	61
Selection of site	18	64
Selection of built-in features	21	75
Selection of furnishings	4	14
Others	4	14

Table 4

Control of Home Functioning

	Extent of Involvement		Perferred Involvement	
	No.	%	No.	%
Totally automatic	1	4	5	17
Somewhat automatic	4	14	3	11
Occupant/automatic	10	36	14	50
Somewhat occupant	7	25	3	11
Totally occupant	6	21	3	11
Total	28	100	28	100

function, one-half of the homeowners wanted an equal combination of automatic and occupant control. Five (18%) owners preferred totally automatic controls and 3 (11%) preferred totally occupant controlled functioning (Table 4). A total of 61% of the homeowners wanted to be directly involved in the functioning of their solar systems. Perhaps this is an indication of their desire to become more self-sufficient and responsible for energy consumption.

Respondents were presented a grid and asked to check the frequency of the actions that must be taken to make their passive systems function optimally (Table 5). The majority of actions were performed twice a day or daily, indicating a high degree of involvement and accepted responsibility by the homeowner for the benefits gained from the solar features. Seventy-five percent reported they were consistent to very consistent in performing the tasks associated with the maximization of the solar equipment in the home. This effort is an indication of the commitment to solar energy utilization design by the homeowners. The remaining subjects noted varing degrees of consistency (Table 6).

A large majority (89%) of the sample found that they liked to perform the tasks associated with their passive solar homes. Relative to homeowner tasks, a participant said "that getting something for nothing is pretty good" and even though some assumed responsibility for the functioning, this action was "far superior to writing large checks to a utility company". These findings are consistent with Hamrin, as cited in Unseld and Crews (1978), who reported that people selecting experimental housing wanted greater self-sufficiency, and were willing to make some lifestyle and behavioral setting changes.

Table 5

Involvement in Home Functioning

Action	Twice Daily		Daily		Weekly		Monthly		Seasonally	
	No.	%	No.	%	No.	%	No.	%	No.	%
Open/closing shutters	6	21	1	4	0	0	0	0	0	0
Open/closing drapes	6	21	5	18	0	0	0	0	0	0
Open/closing shades	6	21	2	7	0	0	0	0	0	0
Open/closing insulation	7	25	4	14	0	0	0	0	0	0
Adjusting thermostat	1	4	2	7	0	0	2	7	10	36
Applying overhangings	0	0	1	4	0	0	0	0	5	18
Storm windows/doors	1	4	0	0	0	0	0	0	3	11
Cleaning windows	0	0	0	0	1	4	5	18	13	46
Turning on fans	2	7	4	14	1	4	0	0	5	18
Putting on extra clothing	0	0	10	36	0	0	0	0	5	18

Table 6

Performance of Tasks Associated With Home Functioning

Performance of Tasks	No.	%
Very consistent	13	46
Consistent	8	29
Somewhat consistent	2	7
Inconsistent	2	7
Very inconsistent	2	7
No response	1	4
Total	28	100

Performance of Rooms and Solar Features

Respondents were asked to identify ways in which their current homes were used differently from previous non-solar homes. Almost half (47%) reported some change in room use. Three described the use of the great room, which is a combination of living room, kitchen and dining room. Many activities such as bookwork, television viewing, playing games, listening to music, family visiting, and formal visiting took place in this area. Ten (36%) made greater use of common rooms, six (21%) entertained to a larger extent and stayed at home more (Table 7). Four (14%) subjects described the use of rooms in different seasons. Greenhouses were used as a place for entertaining in the summer and as a location for work and enjoyment of the sun in the winter. Bedrooms were used for fewer activities in the winter because of the lower ambient room temperatures.

There appears to be a trend toward more functional design features incorporated into passive solar homes. Common rooms were used for various family activities as well as for more formal entertaining events. The greenhouse was not only a functional solar collector but was used throughout the seasons for different family affairs. This area provided a place for growing food and plants, leisure and enjoyment of the sun, work, and entertaining.

One of the contributions of this research was to ascertain specific data on room use. This multipurpose use of rooms seemed to indicate a change in lifestyle and consequent behavior patterns of owners of passive solar homes. The literature was void of references dealing with this aspect of behavior within this environment.

Slightly more than half (54%) described unanticipated benefits

Table 7

Home Room Use

Home Use	No.	%
Entertain more	6	21
Entertain less	0	0
Use bedrooms more	1	4
Use bedrooms less	2	7
Use common rooms more	10	36
Stay at home more	6	21
Other	1	4

of owning passive solar homes. Several were more aware of the cycles occurring in nature, including a heightened awareness of weather, climate, and seasons. Greater privacy and quietness were also highlighted. Yet others noted such factors as educating friends about solar energy, the virtues of natural lighting, and the comfortable interior environment. Several respondents commented on a new feeling of independence from utility companies for heating and lighting interior spaces.

According to Unseld and Crews (1978), Lorriman employed a user/owner assessment of life in a solar home. He reported an increased awareness of weather conditions. Wilson, in his survey of the Missouri solar consumer, cited by Unseld and Crews (1978), noted that the respondents had a feeling of pride in ownership when the reactions of friends and neighbors were favorable. The findings of this research are consistent with those of Lorriman and Wilson.

Participants were asked to rate the performance of each of the solar features incorporated into their homes. Mechanisms included direct gain, indirect gain, isolated gain, hybrid system, and a combination system. In general all of these were rated OK to high as functional units. The direct gain system, which incorporated south-facing glass with a thermal mass floor, was rated OK-to-high by 23 (82%) owners. Trombe walls in 12 (43%) homes, which referred to an indirect gain, were rated as satisfactory. Other features were somewhat less popular (Table 8). As a result of these particular design features, a large majority (89%) reported savings on their fuel bills.

Unseld and Crews (1978) noted that savings on fuel bills were reported by several researchers. These studies included Sawyers sample of solar consumers in the southwestern and northeastern United States;

Table 8

Performance of Solar Features

Solar Feature	High		OK		Low	
	No.	%	No.	%	No.	%
Direct gain	16	57	7	25	0	0
Indirect gain	5	18	7	25	0	0
Isolated gain	5	18	4	14	0	0
Hybrid system	5	18	4	14	0	0
Combination	3	11	3	11	0	0
Other	1	4	0	0	1	4

respondents from the Subcommittee On Oversight and Investigation study sites in California, Michigan and Wisconsin; Wilson's study of the Missouri solar consumer; and a survey from The Solar Energy Research Institute that included solar homeowners from almost every state. These savings on fuel bills indicated that the performance of the incorporated solar features was satisfactory. Sawyer, as cited in Unseld and Crews (1978), reported that this satisfaction did not appear to be related only to financial savings, but to the expectations of the functioning of the system.

Along with the positive features associated with passive solar homes, some subjects (54%) listed complaints. Some dissatisfaction with construction techniques was evident. Others noted that cooling in the summer and heating in the winter posed problems. Sometimes ventilation, humidity, and retention of odors were perceived as less than satisfactory. Only one individual noted the high monetary cost of constructing a custom built home.

Unseld and Crews (1978) reported areas of dissatisfaction that had been previously determined. Included in this report were the findings of Lorriman who noted a problem in his home with excessive heat gain. The Solar Energy Research Institute, The Subcommittee On Oversight and Investigation, and Wilson all concluded that subjects had problems locating reliable equipment and installation maintenance service.

The thermal comfort of the interior of the home during different weather conditions (cloudy, sunny) and seasons (winter, spring, summer, fall) was rated (Table 9). For descriptive purposes, three of the categories were combined: slightly cooler than comfortable, comfortable,

Table 9

Thermal Comfort

Comfort Level	Winter Day				Spring Day				Summer Day				Fall Day			
	Cloudy		Sunny		Cloudy		Sunny		Cloudy		Sunny		Cloudy		Sunny	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Uncomfortably cold	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cooler than comfort	3	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Much cooler	4	14	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Slightly cooler	9	32	1	4	4	14	0	0	1	4	1	4	6	21	0	0
Comfortable	9	32	17	61	18	64	14	50	12	43	6	21	15	54	15	54
Slightly warmer	0	0	8	29	1	4	8	29	6	21	6	21	0	0	5	18
Much warmer	0	0	0	0	1	4	1	4	0	0	4	14	0	0	0	0
Hotter than comfort	0	0	0	0	0	0	0	0	1	4	2	7	0	0	0	0
Uncomfortably hot	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

and slightly warmer than comfortable. In general, most subjects found their homes to be fairly comfortable year round. About a fifth (21%) were cold in the winter and too warm in the summer. Sunny winter days (94%) were more comfortable than cloudy ones. Cloudy summer days (68%) were more comfortable than sunny days. Virtually no difference was reported between cloudy and sunny spring days. On cloudy fall days some slightly cooler temperatures were experienced than on sunny days. Looking further at the data, it was observed that during the winter, spring and fall seasons a number of people were a little cool on cloudy days and a little warm on sunny days. Responses were not found in the uncomfortably cold and uncomfortably hot categories. Perhaps subjects were reluctant to check the extreme choices. However, within another context, one owner complained that "it gets hotter than hell in the summer".

When the temperatures in the homes were either too warm or cold a number of actions were initiated. When the rooms were warm subjects opened windows to increase air flow, wore lightweight clothing, activated the fan system and air conditioners. Subjects who felt cold wore heavier clothing, utilized wood stoves or fireplaces, and turned on auxiliary heat. It is interesting to note that the actions were taken in the order listed to conserve as much energy as possible. As we as a nation have become more concerned about energy utilization, many strategies have been devised and are being used to help insure comfort in our environments.

Satisfaction With Home and Furnishings

Extent of satisfaction with selected aspects of the homes were

rated. Space was provided on the questionnaire for comments related to satisfaction. A majority (89%) was satisfied with the exterior, and a like number (96%) were satisfied with the interior. A similar trend was observed for overall satisfaction (92%). It should be noted that none of the participants expressed real dissatisfaction.

A number of pertinent comments were provided regarding feelings of satisfaction in an open-ended question. General enthusiasm for solar design was apparent, for one individual provided keys to the contractor to permit interested clients to spend a weekend at his home. Two persons noted that the execution of the design was much better than expected and that the home was beautiful as well as functional. Another expressed satisfaction with the solar look in spite of neighbors commenting that the design was "too solar" for the subdivision.

Conflicting points of view were registered about the interior. One individual was very satisfied with the interior furnishings and noted that he was satisfied with the floor plan. Another person was dissatisfied with the interior relative to thermal comfort. He disliked the back-up forced air heating system as well as the suspended ceiling. No comments were made concerning aesthetic qualities.

Unseld and Crews (1978) reported findings from: Cook, Conelly and Garret; and Sawyer; from Leonard-Barton; and Yarosh and Litak, all indicating the majority of solar homeowners were satisfied with their solar systems.

Seventy-five percent of the homeowners had a thermal mass in the floors of their passive solar homes. Of these, 18 (64%) were satisfied with the hard floor surface. Those who were dissatisfied expressed concerns that the thermal mass used was not an appropriate

material for solar heat gain and storage. Eight (29%) subjects covered parts of the thermal mass with area rugs (Table 10). With the exception of one individual these rugs were placed beyond the point of sun penetration and covered only a small amount of floor space.

The majority (82%) of the participants had not purchased specific furnishings that they felt would perform well in their solar homes. Those who did purchase specific furnishings chose light airy pieces and light to earth tones so that fading would not be readily apparent. Eleven percent had trouble with fading window treatments, wall hangings, upholstered pieces, carpeting and accessories. It is important to note that many respondents had not lived in their homes long enough to give conclusive evidence about fading of these artifacts. Seven (25%) homeowners experienced problems with glare due to the solar features of the home, however the majority corrected these problems with shades, blinds or draperies.

Three-fourths of the homeowners reported the use of some type of energy efficient window treatments. Several (25%) had double or triple pane windows, a couple (7%) had insulated draperies, and 25% used shutters or shades. An additional five (18%) respondents indicated that they had made or purchased window quilts. This window treatment is most often a roller-like shade device of one or more sheets of aluminized Mylar, sometimes in combination with fiber-filled cloth. These quilts are designed to form a tight fit around the window in order to prevent air flow. Many times these treatments are used in combination with interior shutters to add an extra layer of insulation.

Table 10

Specific Interior Features

Interior Feature	Yes		No	
	No.	%	No.	%
Window treatment	20	71	8	29
Thermal mass floor	21	75	7	25
Satisfied with mass	18	64	2	7
Covered thermal mass	8	29	11	39
Purchased furnishings	4	14	23	82

Chapter 5

SUMMARY AND CONCLUSIONS

This study investigated homeowner satisfaction, use, and extent of involvement with the passive solar home. Demographic information was obtained to characterize the sample. Although the review of literature revealed that a few studies have dealt with homeowner satisfaction with the passive solar system, none ascertained satisfaction of interior treatments or the use of rooms by the homeowner.

Participants in this study tended to be fairly young. The major portion were between 30 and 39 followed by the 20 to 29 age group. Approximately equal numbers of adult males and females resided in the solar homes, as well as a child in practically every household. The largest number of people had incomes between $20,000 and $50,000 followed by those in the $50,000 to $75,000 range. A few of the respondents had incomes of $75,000 and above.

The following objectives were developed for this study.

(1) To determine the reasons individuals live in solar homes.

(2) To determine the means used by individuals to become informed about solar energy.

(3) To determine the extent of involvement of the homeowner with the passive solar system's functioning.

(4) To determine the perceived performance of the passive solar features.

(5) To determine the extent of satisfaction with the

general interior, exterior, and overall features of the passive solar home.

Sample

The data were obtained from 28 owners of passive solar homes in the state of Virginia. Initial contacts with prospective respondents were made through local chapters of the Virginia Solar Energy Association. Cooperation was gained from the homeowners and participation in the research (Virginia Passive Solar Study) was explained. Questionnaires were distributed at the local chapter meetings. Of the 63 distributed, 28 were returned and completed in their entirety. All were deemed appropriate for analysis.

Instrument

A self-administered questionnaire was developed by cooperating researchers at Virginia Polytechnic Institute and State University. Items were developed to measure homeowners' satisfaction with the interior, exterior, and the overall performance of passive solar homes; aspects of selected interior treatments; and use of rooms.

The questionnaire contained 49 items and was divided into five sections. The questions incorporated in the first four parts of the opinionnaire were used for this research. Approximately 30 minutes were needed for completion of the instrument.

Major Findings

(1) A vast majority of the respondents indicated that saving money on fuel bills was a major factor in their decision

to live in passive solar homes. Over three-fourths noted the feeling of sunlight and warmth, were pleased with the design of their homes, and were interested in saving non-renewable resources. It appears that environmental, energy, and economic concerns are strong values of individuals who have chosen to live in passive solar homes.

(2) Three-fourths of the participants sought information about solar energy utilization through personal research and articles in magazines or newspapers. Over half consulted specialists and periodicals concerning solar adaptations that would meet their needs. These findings indicate that individuals considering solar design as a viable housing alternative conduct a significant amount of personal research in order to make an educated choice.

(3) Over half of the homeowners were responsible for the building or modifications of their homes and wanted to be directly involved with the functioning of their solar systems. The majority of actions associated with the operation of the solar features were usually done once or twice a day. Three-fourths reported being consistent to very consistent in performaing these tasks. A majority found that they liked this involvement with the functioning of their homes. It appears that many of these respondents were do-it-yourselfers and were willing to make changes in lifestyle and behavior

patterns to gain maximum benefit from their passive systems.

(4) All of the solar features incorporated in these passive solar homes were rated OK to high as functional units. The direct and indirect gain systems were the most commonly used.

As a result of utilizing these particular systems a majority of homeowners reported savings on fuel bills. Slightly more than half described unanticipated benefits of owning their homes. An increased awareness of nature and natural lighting, the comfortable interior environment, and a feeling of independence were most often cited. Along with the benefits, a few respondents revealed areas of dissatisfaction. Several were not pleased with certain construction techniques. Others noted problems with heating and cooling, ventilation, humidity, and odors.

Almost half of the respondents reported change in room use in their current residences as compared to previous non-solar homes. One-third made greater use of common rooms and one-fifth entertained to a larger extent. There appears to be a trend toward a more functional design and multi-purpose use of rooms incorporated into the passive solar home.

(5) A majority were satisfied with the general interior, exterior, and overall features of their passive solar homes. Several factors may help to account for this:

(1) owners were highly involved in seeking information about the design and built many of their homes, (2) their participation in the functioning of the solar features appeared as a rewarding tasks, and (3) these owners were extremely conscious about the use of an alternative energy source.

(6) Over half of the respondents had a thermal mass in the floors of their homes and were satisfied with this hard floor surface. A majority had not purchased specific furnishings for their solar homes and had little or no problem with fading. Many of the sample had not lived in their homes long enough to draw conclusions about the effects of fading of interior treatments.

Implications for Further Study

Suggestions for further research involving passive solar homes and their interiors evolved during the course of the research. This type of study could be expanded to include owners of solar homes from other parts of the United States to determine if their attitudes are similar to those individuals living in Virginia. If repeated studies obtained like results then findings might be generalized to a wider population.

Different results might occur if this research were duplicated with a sample who had lived in their homes for a sustained period of time. Many factors such as performance of the solar features, their pay-off period, use of interior furnishings and their durability, and changes in lifestyle behavior could be more established.

Because perceived amounts of natural light, feelings of warmth from the sun, and an increased awareness of nature have been cited by owners of passive solar homes as additional benefits, these feelings could be compared to those of owners of conventional homes. Research on design techniques used to incorporate these desirable benefits in various types of structures might result in interiors that are functional as well as psychologically and physically comfortable for the inhabitants.

Multipurpose rooms are featured in many passive solar homes. Additional research might be conducted on the design and function of interior furnishings appropriate for highly flexible living spaces. In these new interior environments many demands are placed on the textiles used for upholstery and window treatments. More functional textile treatments may be needed which will withstand heavy use and prolonged exposure to sunlight to make these homes truly functional as well as beautiful.

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APPENDIX

FAMILY AND HOME PROFILE

Passive Solar Study

This survey is being conducted to collect varied and detailed information from owners of passive solar homes. Technical information about the performance of your home and your attitudes toward it are being sought. The information we seek covers a range of areas: family characteristics, family schedule, user of the home, decisions in obtaining a solar home, energy consumption patterns, and assessment of your satisfaction.

Please be assured that all information gathered will be held in the strictest confidence. After your questionnaire is received all of your data will be identified with a number only and your name will be eradicated.

Thanks for your help in completing this questionnaire.

HOMEOWNER QUESTIONNAIRE
Passive Solar Study Group

Name _____

Address _____

_____

WE WOULD LIKE TO ASK YOU SOME QUESTIONS ABOUT YOUR RATIONALE FOR LIVING IN A SOLAR HOME.

1. Why do you live in a passive solar home? (Check all of the appropriate responses)

____ Saves money on fuel
____ Saves non-renewal natural resources
____ Like the design of the house
____ Was the best house available in this area
____ Was an accident, we didn't know it was a passive solar home
____ Wanted to demonstrate an alternative energy idea
____ Like the feeling of sun - light and warmth
____ Other: _____

_____

_____

2. What conditions led to your living in a solar home? (Check all of the appropriate responses)

____ We hired someone to design the house for us.
____ We had it built to our specifications.
____ We bought an existing solar home.
____ We modified our existing home.
____ Other: _____

_____

3. Who was responsible for the building and/or modification? (Check all of the appropriate responses)

____ Architect
____ Design/Build Firm
____ General Contractor
____ Self
____ Other: _____

4. How did you become informed about solar energy utilization in homes? (Check all appropriate responses)

____ National Solar Heating and Cooling Information Center
____ An architect or builder
____ Friends or family
____ Personal research
____ School or course work
____ Articles in magazines or newspapers
____ Other: _____

_____

5. What sources did you use to find additional information about the solar adaptions that would meet your needs? For example, cost associated with shutters, vents, automatic or occupant controlled. (Check all appropriate responses)

____ Library
____ Periodicals
____ Media
____ Consulting specialists
____ Community organizations
____ Other, (please specify) _____

6. Did you have trouble locating information?

____ yes ____ no. If yes, check the extent.

____ A lot of trouble
____ Some trouble
____ Very little trouble
____ No trouble

Comments: _____
_____
_____
_____

7. If you were in a position to build a new solar home, what would you do differently?

_____

_____

_____

8. Please list circumstances under which you would buy or build a home which did not incorporate passive solar features?

_____

_____

_____

9. How satisfied are you with your passive solar home? Please rate your response to the exterior, and interior conditions, as well as overall response.

	Exterior	Interior	Overall
Very satisfied			
Satisfied			
Somewhat satisfied			
Somewhat dissatisfied			
Dissatisfied			
Very dissatisfied			

Additional Comments:

PASSIVE SOLAR HOME DESIGN AND FUNCTION ARE DIFFERENT FROM THAT OF CONVENTIONAL HOMES. WE WOULD LIKE TO ASK YOU SOME QUESTIONS ABOUT THE DESIGN AND FUNCTION OF YOUR SOLAR HOME.

10. Do you use this house differently from previous non-solar homes?

____ yes ____ no If yes, check all appropriate responses

____ Entertain more
____ Entertain less
____ Use bedrooms more
____ Use bedrooms less
____ Use common rooms more
____ Use common rooms less
____ Stay at home more
____ Stay at home less
____ Other: _____

_____

11. Were you involved with the design of your solar home?

____ yes ____ no If yes, check all appropriate responses.

____ Physical labor
____ Design of floor plans
____ Selection of solar features
____ Selection of site or orientation
____ Selection of built-in features (such as special fireplace, cabinets, etc.)
____ Selection of interior furnishings
____ Other: _____

_____

12. How knowledgeable do you feel your architect and/or builder(s) were on solar design?

Architect	Builder
____ Uninformed	____ Uninformed
____ Poorly informed	____ Poorly informed
____ Adequately informed	____ Adequately informed
____ Well informed	____ Well informed
____ Not applicable	____ Not applicable

13. If poorly or uninformed, to the best of your knowledge did they do any of the following. (Check all that are appropriate)

____ Consult other architect or contractors
____ Consult specialists on problem areas
____ Consult manufactures
____ Read reference journals and books
____ Not applicable
____ Other: _____

_____

14. Do you save on your fuel bills? ____ yes ____ no

Do you have records which keep track of energy expenditures?

____ yes ____ no

If yes, what kind and what have you learned?

_____

_____

15. Check the specific solar features incorporated in your home by rating the performance. Comment about any problems you may have encountered in obtaining or installing the materials.

Solar Feature	Rating			Comments
	High	OK	Low	
Direct gain (south-facing glass with thermal mass floor)				
Indirect gain (trombe walls or water wall)				
Isolated gain (greenhouse)				
Hybrid system (combination of active and passive system)				
Combination system (two or more systems)				
Other:				

16. On a scale of 1 - 5, describe the extent of your involvement with the functioning of your home? (Automatic control does not require any human involvement; occupant control requires human involvement to operate functions) (Circle one)

Totally Automatic		Combination		Totally Occupant
1	2	3	4	5

17. How would you like your home to function? (Circle one)

Totally Automatic		Combination		Totally Occupant
1	2	3	4	5

18. Check the frequency of the actions that must be taken to make your passive system function optimally?

Action

	2/day	daily	weekly	monthly	seasonally
Open/closing shutters					
Open/closing drapes					
Open/closing shades					
Open/closing moveable insulation					
Adjusting thermostat					
Applying overhangs or shading devices					
Using storm windows and doors					
Cleaning windows					
Turn on fans					
Put on extra clothes					

19. How consistent are you in performing the above tasks? (Circle one)

Very Consistent		Somewhat		Very Inconsistent
1	2	3	4	5

20. To what extent do you like performing the actions associated with your solar home?

____ Very much
____ It's OK
____ It's a bother
____ I hate it

Comments:_____

_____

21. Have you become aware of additional benefits of owning a passive solar home that you had not anticipated?

____ yes ____ no If yes, comment:

_____

_____

_____

22. Do you have any complaints about your passive solar home? (anticipated or unanticipated?)

____ yes ____ no If yes, explain.

_____

_____

_____

_____

23. How would you rate the thermal comfort of your home in various weather conditions and different seasons? (Place the number best represents your thermal comfort in all of the boxes in the following grid)

1 - uncomfortably cold
2 - colder than comfortable
3 - much cooler than comfortable
4 - slightly cooler than comfortable
5 - comfortable
6 - slightly warmer than comfortable
7 - much warmer than comfortable
8 - hotter than comfortable
9 - uncomfortably hot

Weather

	Winter		Spring		Summer		Fall	
	Day	Night	Day	Night	Day	Night	Day	Night
Cloudy								
Sunny								

24. If you feel either too warm or too cold, what, if anything do you do to become more comfortable?

Too warm: _____

_____

_____

Too cold: _____

_____

_____

INTERIOR DESIGN CAN AFFECT THE PERFORMANCE OF A SOLAR HOUSE. WE ARE INTERESTED IN YOUR OPINIONS.

25. Do you have insulating window treatments in your home?

____ yes ____ no If yes, what type? _____

_____

26. Do you have a thermal mass in the floor of your passive solar home?

____ yes ____ no

What material is the thermal mass? _____

Amount of floor space? _____

If yes, are you satisfied with the hard floor surface?

____ yes ____ no

If dissatisfied, what have you done to correct the problem? Please comment:

_____

_____

27. Have you purchased specific furnishings that you feel perform well in your solar home?

____ yes ____ no If yes, explain:

_____

_____

28. Have you had any problem with fading of any of the following furnishings due to the solar features of your house?

____ yes ____ no

Comments

Window treatments _____

Wall hangings _____

Upholstered pieces _____

Carpeting _____

Wooden objects _____

Accessories _____

_____

29. Have you had any problems with glare due to the solar features of your house?

____ yes ____ no If yes, what have you done to correct the problem?

_____

_____

30. List all the rooms in your house. Please indicate any way that your family uses any room which may be somewhat unusual. (For example, entertaining in the kitchen, work area in bedroom, etc).

Room Use

_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____

31. Do you use rooms differently in different seasons of the year?

____ yes ____ no If yes, please explain: _____

_____

32. For all the activities listed below, check the room or rooms in which the activity usually occurs.

Activity

	LIV	DIN	KIT	BDR	BATH	DEN	FAM	GH*	OTH
Intense reading/bookwork									
Light reading/bookwork									
Communal TV viewing									
Private TV viewing									
Communal music									
Private music									
Inf table dining									
Formal table dining									
Snacking									
Playing table games									
Napping									
Night sleeping									
Phone conversations									
Family visiting-adults									
" " - children									
Machine sewing									
Hand sewing									

* Greenhouse

33. Please indicate name, age, sex and occupation of all persons living in your home.

Name	Sex	Age	Occupation	Place of work/study

34. What is your total family income from all sources? (Check one)

____ $ 0 - 10,000
____ 10,000 - 19,999
____ 20,000 - 34,999
____ 35,000 - 49,999
____ 50,000 - 74,999
____ 75,000 - plus

35. What types of dwelling places have you lived in since moving from your parents home? (Excluding dorms, barracks and your present home)

Adult #1 _____

_____

Adult #2 _____

_____

36. How many of these residences did you have built? (Excluding this one) _____

37. In order to analyze the solar data on your home, we need to know the usual schedule of your family and when your home is occupied and not occupied.

Please mark approximate time that members of your household:

	Adults	Children
Get up		
Go to bed		
Have meals		

On an average winter day, how often does some member of your family open a door that leads to the outside?

____ weekdays ____ weekends

	Weekday		Weekend	
	Occupied*	Not Occupied	Occupied*	Not Occupied
12am - 1 am				
1 am - 2 am				
2 am - 3 am				
3 am - 4 am				
4 am - 5 am				
5 am - 6 am				
6 am - 7 am				
7 am - 8 am				
8 am - 9 am				
9 am - 10am				
10am - 11am				
11am - 12am				
12am - 1 pm				
1 pm - 2 pm				
2 pm - 3 pm				
3 pm - 4 pm				
4 pm - 5 pm				
5 pm - 6 pm				
6 pm - 7 pm				
7 pm - 8 pm				
8 pm - 9 pm				
9 pm - 10pm				
10am - 11pm				
11pm - 12am				

*occupied - at least one family member at home

Please mark an X indicting whether or not your home is occupied during the day-for weekdays and weekends. We understand that this will be an approximation of your general schedule.

WE ARE ALSO INTERESTED IN BRIEFLY ASSESSING YOUR ENVIRONMENTALLY RELEVANT PRACTICES. PLEASE COMPLETE THE FOLLOWING ITEMS.

38. Type of car:

Make _____ Type _____

Year _____

39. How do you usually commute to and from work?

Adult #1	Adult #2	
_____	_____	Single occupant car
_____	_____	Car with two or more passengers
_____	_____	Van
_____	_____	Bus
_____	_____	Motorcycle
_____	_____	Bike
_____	_____	Walk
_____	_____	Other

40. Have you had installed any of these water-saving devices in your home? (Check all that apply)

____ Shower flow restrictors
____ Toilet dams
____ Other

41. Do you have a vegetable and/or fruit garden? ____ yes ____ no

42. If yes, is the garden important for providing some part of your food?

____ yes ____ no

43. Are there any other important environmentally related practices or behaviors in which you are regularly engaged? If yes, please list:

_____

_____

44. Are you an active member in any club or group whose primary interest is energy?

____ yes ____ no If yes, list the group(s)?

_____

45. List the ways you find this group helpful to you and note how it could better meet your needs.

_____

_____

_____

46. What problems can you foresee in keeping daily records?

_____

_____

List the ways in which the record-keeping could be made easier?

_____

_____

47. Do you anticipate any problems in recording auxiliary energy use?

____ yes ____ no If yes, explain: _____

_____

48. Who will assume major responsibility for recording the minimum/maximum temperatures each day?

_____

49. Finally, if there were three things that you wanted to tell us about your solar home, or your experiences as a solar home owner, what would they be?

1. _____

2. _____

3. _____

Please contact us if you find there are major constraints to your record-keeping.

A FEW OF OUR QUESTIONS REQUEST INFORMATION ABOUT ATTITUDES OR PERCEPTION OF TEMPERATURE. FOR THIS REASON WE ARE ASKING THAT THE ADULT IN THE FAMILY WHO DID NOT COMPLETE THE QUESTIONNAIRE PLEASE TAKE A FEW MINUTES AND ANSWER THE QUESTIONS BELOW.

50. Why do you live in a solar home? Check appropriate responses:

_____ Saves money on fuel
_____ Saves non-renewal natural resources
_____ Like the design of the house
_____ Was the best house available in the area
_____ Was an accident, we did not know it was a passive solar home
_____ Wanted to demonstrate an alternative energy idea
_____ Like the feeling of sun-light and warmth
_____ Other: _____

51. How would you rate the thermal comfort of your home in various weather conditions and different seasons? (Please put the number which most represents your thermal comfort in the appropriate boxes).

1 - uncomfortably cold
2 - colder than comfortable
3 - much cooler than comfortable
4 - slightly cooler than comfortable
5 - comfortable
6 - slightly warmer than comfortable
7 - much warmer than comfortable
8 - hotter than comfortable
9 - uncomfortably hot

Weather	Season							
	Winter		Spring		Summer		Fall	
	Day	Night	Day	Night	Day	Night	Day	Night
Cloudy								
Sunny								

52. If you feel either too warm or too cold, what, if anything, do you do to become more comfortable?

Too warm: _____

_____

Too cold: _____

_____

53. Finally, if there were three things that you wanted to tell us about your solar home, or your experiences as a solar home owner, what would they be?

1. _____

2. _____

3. _____

T H A N K S

_____

Name

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Passive Solar Homes And Their Interiors:

Homeowner Attitudes

by

Patricia D. Ross

(ABSTRACT)

This research investigated homeowner rationale for, and feelings about, living in passive solar homes. Satisfaction, use, and extent of involvement with the home and solar features were determined. Twenty-eight owners of passive solar homes from the state of Virginia participated in this study. Data were collected by a hand-delivered questionnaire which was self-administered.

Frequency and percentage distributions were calculated to describe the sample and characterize the findings from the study. Findings that were of a significant nature indicated that a vast majority of respondents felt that saving money on fuel bills was a major factor in their decision to live in passive solar homes. Over three-fourths of the homeowners sought information about solar energy utilization in order to make an educated choice. Over half were responsible for the building or modification of the homes and were directly involved with the functioning of their solar systems. All of these solar features were rated OK-to-high as functional units.

Slightly more than half of the homeowners described unanticipated benefits as well as complaints related to their homes. Savings on fuel bills resulted in feelings of independence from utility companies for many of the respondents. Several were also pleased with their new awareness of nature and the weather. Areas of dissatisfaction were most

often related to construction techniques. Others noted that cooling in the summer and heating in the winter posed problems. Almost half of the respondents reported changes in room use in their current residence as compared to previous non-solar homes. There appears to be a trend toward a more functional design, and multipurpose use of rooms incorporated into passive solar homes. Over half had a thermal mass in the floor and were satisfied with the hard floor surface. A majority had not purchased specific furnishings that they felt would perform well in their solar home and have had no problem with fading. Overall, homeowners were satisfied with the general interior, exterior, and overall features of their passive solar homes.