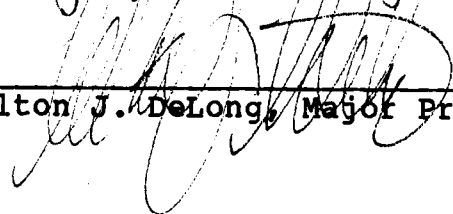


To the Graduate Council:

I am submitting herewith a dissertation written by Joan H. McLain-Kark entitled "User Participation in Passive Solar Housing Design." I have examined the final copy of this dissertation for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy with a major in Home Economics.


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**USER PARTICIPATION IN
PASSIVE SOLAR HOUSING DESIGN**

A Dissertation

Presented for the

Doctor of Philosophy

Degree

The University of Tennessee, Knoxville

Joan H. McLain-Kark

December 1985

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ABSTRACT

A field study was conducted in 1984 in order to compare the characteristics, lifestyle, attitudes, and behavioral adaptations of two groups of passive solar homeowners, those with high or low levels of participation in the design and/or building process. Forty-one Virginia passive solar homeowners were surveyed and interviewed in their home. Photographic slides and floor plans with furniture layout were also analyzed.

The results indicate that the owner-built homeowners or those with high participation in design and/or building were older, more educated, and were more involved in community affairs than the low participation homeowners. They also were more involved in maintenance tasks, more likely to engage in a voluntary simplicity lifestyle, and more energy conserving. The owner-builders too had a higher level of satisfaction with their home.

The majority of the homeowners expressed dissatisfaction with the flexibility of arranging furniture in the open plan. An analysis of the floor plans revealed that three factors were contributing to the problem: zones, circulation/furniture arrangement, and passive elements. Zones or distances between different activity zones were examined. In the spec-built housing particularly, the distance between entry and living room was restricted and

may have caused homeowner dissatisfaction. The configuration of the circulation through the living room was also dysfunctional. In many cases, circulation to other rooms was through conversational groupings causing segmented seating arrangements. This problem was also confounded in the passive solar subdivision by site orientation. Some homeowners modified the builder's plans by moving the front door to the street location further complicating circulation. Finally, passive elements such as woodburning stoves and thermal mass contributed to space planning problems in some of the homes studied.

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CHAPTER I

INTRODUCTION

Rapidly escalating prices for fossil fuels in the 1970's inspired a flurry of research into alternative energy strategies. One strategy which has emerged in the residential building sector as a feasible alternative is passive solar heating. This simple design technique works with nature to capture the sun's energy for use in heating and cooling of a home. Widespread use of passive solar design in the building sector decreases our nation's dependence upon fossil fuels. In addition, passive solar is economical. Case studies of these homes show that energy savings over fossil fuels can be significant; and, furthermore, initial construction costs may vary only slightly from a conventionally-built house (Taylor, 1979).

Thus, the rationale for adopting passive solar design is strong; yet it remains in a very early adoption stage. A partial explanation is that any housing innovation will require a long time before diffusion or widespread adoption occurs. McCue and Ewald estimate that it will take an average of 17 years for any housing innovation to proceed from invention to first use in the residential construction industry (1970). According to Dagwell (1983), factors such as consumer attitudes, building

codes, zoning ordinances, the nature and structure of the building industry, and lenders' attitudes sometimes impede adoption. Perhaps the most important of these factors is consumer acceptance which is affected by the compatibility of the innovation with a consumer's expectations and needs. Thus, the key to understanding the low rate of adoption of passive solar may lie in examining passive solar design itself. That is, in current practice, designers do not consider user needs and preferences adequately. Furthermore, innovation-adoption theory suggests that user population characteristics change as one moves forward in the process of adoption; and, thus, focusing only on current users is insufficient. Consequently, a comparative study is needed which differentiates among various user groups. Accordingly, this study will address the needs of two groups of early adopters, owners of owner-built and spec-built passive solar homes. It is essential to ascertain whether there are any differences in characteristics and needs of the two groups.

Purpose

The purpose of this study was to examine and compare demographic, attitudinal, and behavioral characteristics of two groups of passive solar homeowners, those with high

and low levels of participation in the design and/or building process.

Objectives of the Study

The specific objectives of the study were:

1. to examine and compare selected variables of demographics, perceived innovation attributes, lifestyle, and values of the two groups of homeowners.
2. to examine and compare satisfaction levels with the passive solar home for the two groups of homeowners.
3. to examine behavioral adaptations to assess the compatibility of the passive solar design with user needs.

Justification

During the last decade, much research has been compiled regarding the energy savings of passive solar technology. However, little research has been conducted on the human response to the innovation. Post-occupancy evaluation studies to date have focused attention on the owner-builder. On the other hand, little research has been done on the later adopter. Yet, if passive solar is to move beyond a small minority of homeowners, it must capture a larger share of the predominant spec-built housing market. Objective research regarding these homeowners' responses to the passive solar environment is

needed in order that designers can base their designs on a more comprehensive understanding of human needs as well as on esthetic and energy considerations.

CHAPTER II

GUIDING RESEARCH AND THEORIES

Innovation-adoption theory provides a guiding framework for this research. Consequently, the theory is presented here along with the related research on passive solar. The first part of this chapter explains the basic tenets of the theory focusing on characteristics of adopter groups. The discussion then moves on to the perceived attributes of the passive solar innovation which affect its rate of adoption and homeowner satisfaction. These attributes are important during the various stages of the passive solar decision process discussed in the next section. Further, the chapter focuses on the primary difference between owner-built and spec-built homeowners, participation in the design and/or building process. With this background of theory and related research, a conceptual model is presented of the satisfaction process of the passive solar homeowners. This model was used to guide this research and to generate a number of hypotheses which are presented at the conclusion of this chapter.

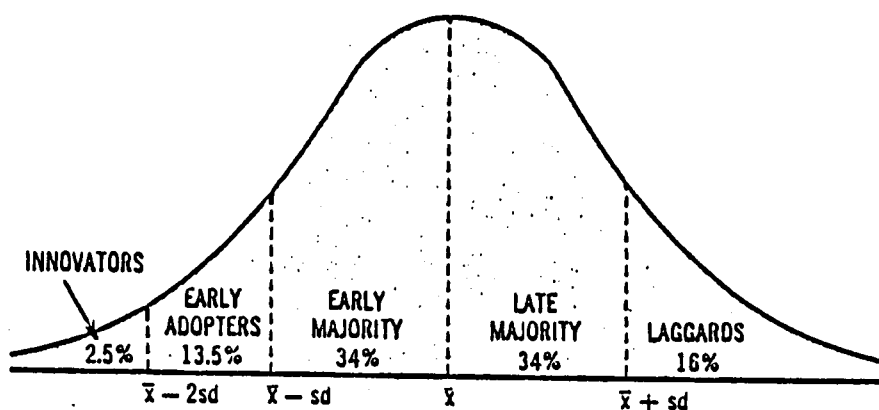
1. ADOPTERS

Living in a passive solar house is a new idea or innovation to most people. Like other innovations, the

adoption of passive solar will follow a similar and somewhat predictable pattern based on the concepts of innovation-adoption theory (Rogers and Shoemaker, 1971). This theory, first of all, maintains that the adoption of innovations is a process which occurs over time. First, a few members of the social system will discover the new idea. Then later, a larger number will adopt. Still later, social pressures will prompt large scale adoption to occur. Finally, There will always be a few who adopt very late or quite possibly not at all. What has just been described can be graphically depicted and statistically verified as a normal distribution (p. 179). Figure II-1 shows the bell-shaped curve of this process. Adopter categories can be set up based on whether people adopt earlier or later than other members of the social system. Much research has been done on the characteristics of persons in each category and a discussion of these follow:

Innovators. The first 2.5% are the most innovative and willing to take the most risks both financially and socially. They are also less integrated into the social system.

Early adopters. The next 13.5% minimize their risks by benefiting from the innovators' experience. They are well educated and are more likely to have financial resources to adopt innovations. Early adopters also are more integrated



The innovativeness dimension, as measured by the time at which an individual adopts an innovation or innovations, is continuous. However, this variable may be partitioned into five adopter categories by laying off standard deviations from the average time of adoption.

(Rogers and Shoemaker, 1971, p. 182
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Figure II-1
Adopter Categorization on the
Basis of Innovativeness

into the social system and can act as opinion leaders which means they can be a catalyst or a detriment to later adoption.

Early majority. The next 34% of adopters are more cautious and are well integrated into the social system.

Late majority. The next 34% are very traditional. For them, social pressures are the primary reason for adoption.

Laggards. The last 16% are the most traditional and least likely to adopt.

A number of studies indicate that solar homeowners fit the innovative or early adopter category (Unsel'd and Crews, 1979; Warkov and Meyer, 1982). In addition, Ross's (1982) study of passive solar homeowners indicates that these homeowners have the same characteristics as early adopters of an innovation, i.e., wealthy and well-educated. Similarly, a comparative study shows not only that solar homeowners are wealthier and more educated than average homeowners, but that they also exhibit more innovative behaviors (Farhar-Pilgrim and Unsel'd, 1982). In addition, this study indicates that solar homeowners are more likely to be opinion leaders giving more justification to the argument that present-day solar homeowners are early adopters (p. 416).

2. PERCEIVED ATTRIBUTES

Innovation-adoption theory also maintains that an innovation's perceived attributes will affect its rate of adoption. Likewise, how passive solar is perceived will affect not only whether it is adopted; but, later, it affects the satisfaction of the homeowner. Perceived attributes, then, which are theorized to adversely or positively affect adoption are relative advantage, complexity, compatibility, trialability, and observability (Rogers and Shoemaker, 1971). Of these, the first three attributes are the most relevant to this study.

Relative Advantage

The attribute relative advantage is "the degree to which an innovation is perceived as being better than the idea it supercedes" (p. 138). For passive solar, relative advantage is often described in terms of economic savings on utility bills. In a survey of over two thousand consumers, investigators found that those people who are most favorable towards solar energy and thus are the next most likely group of adopters feel that economic savings and proof of those savings would be a strong motivating factor in adopting solar (Farhar-Pilgrim and Unseld, 1982). In contrast, present day early adopters do not seem quite as concerned about economics as a major reason for adoption

but, rather, cite other reasons such as conservation or a desire to use energy renewable resources (Unseld and Crews, 1980).

Relative advantage also might be described in terms of increased social status. This may be a more important attribute for later adopters. Innovators are not as well integrated into the social system; consequently, increased social status would not have relevance for them. And early adopters see themselves as opinion leaders or trendsetters. Consequently, although they might adopt passive solar partially to increase their social status, it clearly is not as important to them as for later adopters who tend to be followers of social trends.

Complexity

Passive solar principles may be perceived to be very complex or difficult to comprehend and, thus, this attribute might adversely affect its rate of adoption. Again, earlier adopters may be better able to understand the complexities of passive solar systems since they are better educated. Passive solar housing for later adopters, consequently, may need to be less complex or, rather, perceived to be less complex. This attribute also may affect maintenance activities after adoption. A good

understanding of the principles of system operation should enable the homeowners in performing maintenance functions.

Compatibility

Compatibility is an important concept in this research and may be a key to future adoption. It refers to the degree with which an idea or innovation is "adaptable or harmonious with something known, believed, or done by a potential acceptor" (Barnett, 1953, p. 329). First of all, compatibility implies a referent or context. In the following quotation, Barnett discusses context and the importance of the potential adopter being able to project themselves into an innovative situation:

The meaning that a novelty acquires as a result of its being identified with something familiar is a necessary step in its ideological acceptance, but in many instances it is not the only one. Often identification really only sets the stage for the mental reaction that is for or against it. It establishes an innovative configuration XB or AY---an introduced X that is meaningful in the familiar context B or a familiar A that is meaningful in the introduced context Y---which then poses the problem of acceptability. The housewife who contemplates purchasing a vacuum cleaner to replace the broom to which she has been accustomed must first of all identify herself (A) with, and project herself into the place of, another woman (X) who uses one; or, alternatively, she may identify the vacuum cleaner (Y) with her broom (B) and assimilate it to the context of herself. In either case all that she has done so far is to visualize herself using a vacuum cleaner. This may or may not be acceptable to her; it may or may not conform to her concept of herself in her house-

cleaning capacities, regardless of how she feels about other women using vacuum cleaners (p. 341).

An examination of the concept of context can be further explored by using fractions (DeLong, 1978). For instance, for a potential adopter, a conventional ranch style house may represent a compatible or congruent living environment--a relationship of $1/2$. The numerator or one is the ranch style type of house while the denominator two represents the values and past experiences of the potential adopter or its context. For them, the relationship $1/2$ has meaning. The ranch style homeowner contemplates buying a passive solar home by going on a solar home tour. The first house they tour is a ranch style house with a greenhouse entry with oil drums as storage mass which is a $1/3$ to them. The one again refers to the ranch style house, something compatible or equivalent to past experiences. The oil drums, however, are incompatible with their status values; consequently, the context or denominator is a three, something unfamiliar and incompatible. For them, the $1/3$ relationship has no meaning. The next house on the tour is a rustic contemporary house with a redwood greenhouse with fieldstone storage mass or a $4/8$. Both the solar features (8) and the house itself (4) are new to them but the overall relationship $4/8$ is equal to $1/2$, the initial relationship that had meaning for them. The house

represents the same type of compatibility with status values and thus the meaningful relationship that the original ranch style house held for them.

Compatibility, then, can be thought of as achieving a relationship which is equivalent to an older meaningful one for the client or adopter. The question then becomes whether it is indeed possible to predict these relationships for potential adopters. Clearly, if one knows what the relationship is between passive solar design and the values and past experiences of the adopter, it would be easy to choose the appropriate system or offer a range of alternatives which would be equivalent to the older compatible relationship. The first step in fully understanding these relationships, then, is to identify the areas in which passive solar design should be compatible. And, as the preceding discussion on characteristics of adopters suggests, the perceived importance of each area will undoubtedly change as passive solar moves forward in the adoption process. Accordingly, the following areas are suggested by examining previous research as areas with which passive solar should be compatible:

With Physiological Needs

Thermal comfort. Early passive solar houses (mid-1970's) exhibited large temperature swings. Subsequent

fine-tooling of glazing-to-mass ratios and energy conservation practices have resulted in houses with smaller temperature differentials between day and night. In a survey of 321 passive solar households, investigators found that users reported high levels of thermal comfort (Sachs, et al, 1982). But again, one must remember that these users are early adopters and, thus, their interpretation of thermal comfort may differ from later adopters. For instance, researchers found that passive solar homeowners were likely to use clothing to adapt to the thermal environment (Ross, 1982). In winter, they may wear heavy sweaters and hats during the evenings and shorts and T-shirts by day. This behavior is related to their desire to be energy-conserving and use non-renewable energy resources and may not be the same for other adopters.

Visual comfort. A conventional house has approximately the same amount of window area on all sides of the house. Passive solar design, in contrast, involves a manipulation of window area towards the south side with much less area on other sides resulting in an imbalance of lighting levels. This design feature in itself causes an incompatibility or incongruence with what a potential adopter is familiar. Perhaps more importantly, the resultant glare causes physiological discomfort (McLain and Langdon, 1983). Several post-occupancy evaluation studies have revealed

problems with glare (Towle, 1979; Lorriman, 1978; Ross, 1982). The window configurations as well as the interior design including reflectances of surfaces, furniture arrangements, and window treatments are major factors determining the severity of glare problems (McLain and Langdon, 1983).

With Psychological Needs

Sunlight. A passive solar design must be compatible with the sunlight preferences of the potential adopter. Research has shown a relationship between preference for sunlight and the type of passive system one prefers (McLain, 1983). Specifically, strong sunlight preferences are related to a stronger preference for more direct gain or larger window area while the opposite holds true. Since passive systems strongly differ in the amount as well as control over sunlight on the interior, being able to ascertain people's preference for sunlight may be an important factor determining homeowner satisfaction. One can also speculate that early adopters of direct gain homes (where a profusion of sunlight on the interior is characteristic) have a stronger preference for sunlight than the general public.

Privacy. Privacy is a complex psychological need which is culturally determined (Rapoport, 1969). To illustrate,

individual privacy is highly prized in the United States where rooms are built around activities and a bedroom for each family member is the norm. Interestingly, privacy from the outside world is less important. In fact, the house exterior is often proudly displayed as evidence of family status. As a consequence, family privacy from the outside is normally achieved through window treatments. This is not a particular problem at night for the direct gain solar home where energy-efficient window treatments or movable insulation are pulled down to conserve heat. However, the direct gain aperture or window area must be open during the winter day so privacy needs must be considered in the passive solar design process.

With Values and Lifestyle

Values and lifestyle are two interrelated concepts. Values are usually defined as "enduring beliefs determining general standards of conduct, independent of specific situations" (Farhar-Pilgram and Unseld, 1982; p. 144) while lifestyle can be considered to be the "daily expression of more fundamental values" (p. 143). Inglehart (1977) refers to "materialist" and "postmaterialist" values, a category which he based on Maslow's (1970) heirarchal model of needs. Economics might be associated with materialist or lower heirarchy needs while aesthetics, status, and social

concerns can be considered to be "postmaterialist" values or higher needs.

Research suggests that early adopters of solar energy may differ from later adopters in values as well as family lifestyle. In addition, there is some indication that solar adopters may differ among themselves as well. The following discussion of values and lifestyle characteristics illustrates:

Conservation. In Hamrin's (1978) study of two different solar subdivisions, active solar homeowners (i.e. space heating and hot water heating collectors on roof) did not exhibit as much energy conservation behavior as those in the second subdivision where passive and active (hot water heating) aspects were combined. In the second subdivision, homeowners were willing to make lifestyle adjustments to save energy, something which the "active" households did not feel compelled to do. Both populations, though, felt their homes represented compatibility with their conservation values. Other studies also indicate that solar homeowners have strong conservation values (Wilson, 1979; Sawyer, 1979; Cook, Connelly, and Garrett, 1977; Warkov, 1979; Marylander Marketing Research, 1978). These values might be different from the values of later adopters.

Self-sufficiency. Increased independence from utility companies as well as energy independence may be a value more widely held among early adopters than later adopters. Farhar-Pilgram and Unseld (1982) list self-sufficiency as a psychological need giving solar adopters perhaps a more secure feeling of having increased control over their lives (p. 11).

Status. Increased status or prestige has already been mentioned under relative advantage as a factor in adoption. Likewise, compatibility with socio-economic status is important. Later adopters may have a stronger desire to have a house reflect their socio-economic status.

Lifestyle. Living in a solar house can affect family lifestyle in fundamental ways which can best be explained by first considering the nature of the technology. A passive solar house is designed to be in an ecological balance with the natural environment. Not only is the house designed to collect sunlight, it is also engineered to retard winter winds and insulate against the cold. Attention to site orientation and landscaping also increases natural ventilation and cooling in the summer. The interior of the house, in addition, is carefully planned to maximize the energy-efficiency. Open plan facilitates heat transfer and natural ventilation while specification of interior surfaces for proper reflectances

insures visual and thermal comfort. Moreover, the household members are a crucial component in this ecological system. Movable insulation for windows and vents require user operation as well as a working knowledge of the passive system. Failure to perform these tasks or to do them at the wrong time results in improper operation which leads to lower energy savings and/or comfort. In addition, it is possible that these tasks might interfere with family daily activities. But Zimmerman's (1980) in-depth study of nine Arizona households indicates that family daily routines are not adversely affected. Ross (1982) also finds that passive solar homeowners perform maintenance tasks routinely and enjoy this interaction with their home. Case's (1983) research, in contrast, indicates that problems can occur when occupants are at work or otherwise away from home and a change in the weather necessitates maintenance tasks. These maintenance tasks and other involvement with the home increases the family's awareness of the natural environment and climate (Towle, 1979; Zimmerman, 1980; Ross, 1982; Case, 1983). Zimmerman's research finds other family lifestyle changes including more participation in community energy activities as well as interaction with others about their experiences. Research also suggests that solar homeowners are more apt to engage in a voluntary simplicity lifestyle. In essence,

the objective of voluntary simplicity is to decrease material consumption. The values underlying this lifestyle are: 1.) material simplicity, 2.) human scale, 3.) self-determination, 4.) ecological awareness, and 5.) personal growth (Elgin, 1981; Lovins, 1977; Mitchell and Elgin, 1976). Examples of behaviors which characterize voluntary simplicity are energy conservation, food preservation, gardening, and recycling (Leonard-Barton, 1981). Farhar-Pilgrim and Unseld (1982) find that solar homeowners are more likely to exhibit these voluntary simplicity behaviors than the average homeowner (p. 421). This discussion suggests that living in a solar home may require more involvement in the house and, moreover, a commitment to an energy-efficient lifestyle. Obviously, conservation and self-sufficiency values interrelate with lifestyle to set apart the present-day adopter from the general public. Consequently, the finding that most solar homeowners perform maintenance tasks consistently cannot lead one to the conclusion that future adopters will do the same. On the contrary, future adopters may have less financial resources and thus may be primarily concerned with "materialist" or lower order needs such as economics and be relatively unconcerned about "postmaterialist" values or higher order social needs, i.e. conservation and use of renewable energy resources. As the examination of compati-

bility with values and lifestyle portends, the various ways in which the attributes of the passive solar innovation are perceived will differ for the early versus the later adopter. Moreover, these attributes affect how the passive solar home is evaluated later on by the homeowner. Thus, it is important to discuss the process an individual homeowner goes through in adopting a passive solar innovation.

3. PASSIVE SOLAR DECISION PROCESS

Rogers and Shoemaker (1971) have delineated the steps of the individual's innovation decision process. These steps integrated with the related research are described below:

1. Knowledge. An individual is aware of passive solar and seeks more information. At this time, perceived complexity is important in whether the individual continues in the process.

2. Persuasion. Here a person forms either a favorable or unfavorable impression. At the same time, a person decides whether passive solar is compatible with past experiences and needs. He does this by mentally projecting himself into the passive solar situation (just as Barnett describes in the housewife-vacuum cleaner scenario) and tries to ascertain how he would feel. Thus,

emotion or affective information rather than cognitive information (as is important at the knowledge stage) is important. Along with compatibility, the relative advantage of passive solar over conventional homes is also a significant factor in whether one is persuaded.

3. Decision. A decision to adopt or reject is made.

4. Confirmation. After buying a passive solar house, homeowners go through a confirmation stage in which they seek reinforcement for their decision. In addition, they evaluate the house based on the perceived attributes mentioned earlier. Is the house achieving energy savings? Is glare or overheating a problem (indicating incompatibility with visual or thermal comfort)? Are privacy needs met? If homeowners experience dysfunctions, they cannot very well discontinue or reject their home. Rather, this leads them to a state of cognitive dissonance, a state of disequilibrium which forces them to change their behavior. Festinger (1962) describes the concept: "This theory centers around the idea that if a person knows various things that are not consistent with one another, he will in a variety of ways try to make them more consistent" (p. 93). The solar homeowners make the apparent inconsistency (i.e. problems with system performance and a need to know they made the right decision) consistent by conceptually minimizing the problems and reporting a high level of

satisfaction. Cognitive dissonance theory, then, explains the high satisfaction levels reported in many post-occupancy evaluation studies that also indicate problems with system performance (Unsel'd and Crews, 1980; Ross, 1982).

Another factor which helps to explain the high satisfaction levels in postoccupancy evaluation studies is homeowner participation in the design and/or building process. As the following discussion suggests, this participation not only serves to increase satisfaction; but, it also significantly affects the homeowner's interaction with the home as well.

4. HOMEOWNER PARTICIPATION

Early passive solar houses were almost exclusively custom-built to the particular homeowners' tastes and needs. The homeowners either designed the house themselves or worked very closely with the building designer or architect. In addition, these homeowners participated in the building process, often contributing their own manual labor. But increasingly in recent years, builders are constructing passive solar houses with the objective of selling them on the speculative market. These houses involve little or no user participation in the design or building process. Their numbers are small in comparison to

owner-built solar homes; but, nonetheless, these spec-built homes represent a later stage of passive solar adoption. Research indicates that user design/build participation often increases homeowner satisfaction. Goetze (1972) studied two different approaches to housing rehabilitation, one program with a high level of participation, the other not. Both programs were carried out in Rochester, New York in the same neighborhood to the same FHA (Federal Housing Administration) standards under federal funding. CPT Housing Corp, a non-profit corporation set up by the Third Presbyterian Church, renovated houses for subsequent rental to lower income families. In the BLR (Better Rochester Living) program, lower income families participated in the rehabilitation process and eventually purchased the renovated houses. A comparison of the two approaches reveals that direct expenditures for each house were nearly double for the CPT over the BLR program. As a result, the CPT had to be heavily subsidized while the total per-house costs for the BLR program were low enough with the result that the low income families could afford to buy the houses. Goetz also notes the psychological benefits of the BLR approach: Dwellers have a sense of choice at every stage in the process; and, thus, they can make the home more adaptable or compatible with their living patterns. Thus, user participation affects the

perceived attributes of a home which, in turn, affects the satisfaction of the homeowner. This same concept applies to passive solar housing as well. Consequently, the following section describes a conceptual model for this thesis which synthesizes what has been presented thus far in theory and related research and explains in more detail how participation might affect homeowner satisfaction.

5. CONCEPTUAL MODEL

The comparative study on rehabilitated housing suggests that user participation serves to increase the relative advantage as well as compatibility of the housing with dweller needs. The same can be said of user participation in the passive solar housing process. Figure II-2 is a model which illustrates how participation in the design and/or building process affects the perceived attributes of passive solar housing and, consequently, homeowner satisfaction. A high level of design/build participation, first of all, decreases the perceived complexity of the passive solar house (2.1). Just as complexity is negatively related to the rate of adoption so too is it negatively related to interaction with the home. In many cases, the homeowners have designed and/or built the passive features themselves. Thus, they do not perceive the passive house as complex and, furthermore, have a

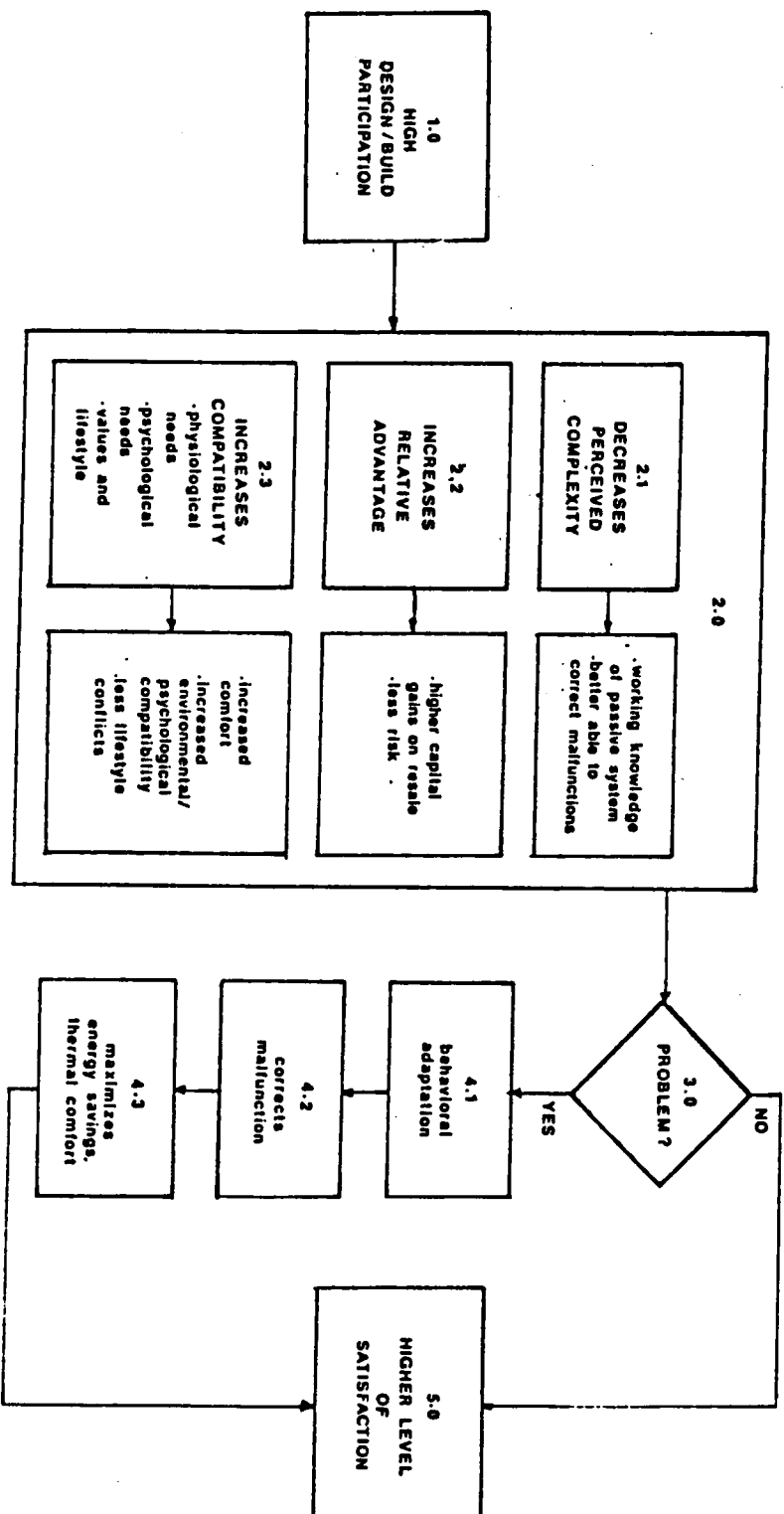


Figure II-2

Model of Satisfaction Process of
High Design/Build Participation
Homeowner

strong working knowledge of the system. Not only would they be in a better position to correct malfunctions or operate the system, but they would also feel a strong need to do so. To do otherwise would mean they have to admit they made mistakes. This may explain partially why several studies indicate that solar homeowners have a hobby-like attitude toward their home, spending spare time in experimenting with or otherwise working on the house (Unsel and Crews, 1980; Case and Warsco, 1978).

This can be contrasted with the spec-built house in which the homeowner has had little or no input into the design or building process. See Figure II-3. Home buyers often learn about the operation of the house through a sales brochure or a real estate agent. As a consequence, the homeowners do not have as strong a background in passive solar principles (thus increased perceived complexity) and, as a result, are less able to correct malfunctions. Accordingly, many spec-builders and developers have issued homeowner operation manuals which explain the passive system and the proper maintenance functions. These manuals, thus, serve to decrease perceived complexity and perhaps avoid homeowner complaints (Loftness, et al, 1981).

A high level of design/build participation also increases the relative advantage of passive solar (Figure II-2; 2.2). By contributing design time and/or manual

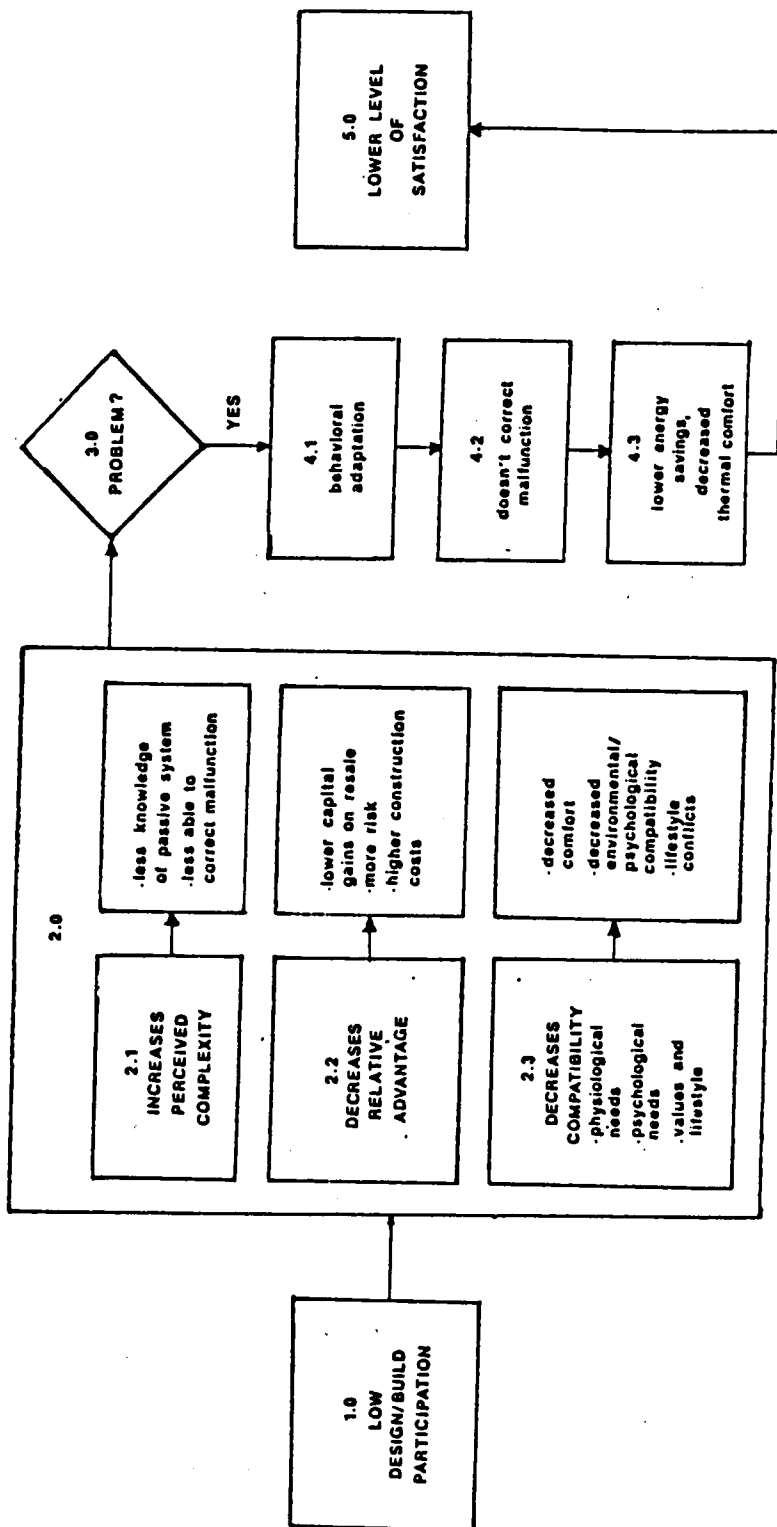


Figure II-3

Model of Satisfaction Process of
Low Design/Build Participation
Homeowner

labor, the homeowners decrease construction costs which results in higher capital gains at resale time. This minimizes their risk. In addition, the owner-builder can utilize labor-intensive but inexpensive construction materials such as fieldstone which enhances the value of the house. In the spec-built house, the same material plus labor adds considerably to construction costs. Thus, the low level of participation of the spec-built homeowner decreases the relative advantage of passive solar for them (Figure II-3; 2.2). Finally, design/build participation increases the compatibility of passive solar with homeowner physiological and psychological needs as well as homeowner values and lifestyle (Figure II-2; 2.3). This is accomplished primarily during the design process during which the homeowners are strong participants. The congruence, too, between homeowner needs and the home is very much dependent upon the designer's knowledge and ability to use passive solar principles, housing design, and knowledge of homeowner needs. But, there is a much stronger chance for compatibility with those needs for the homeowners who extensively participate in the design and/or building process. In contrast, home buyers of a spec-built house can only choose from what is available on the market at the time and these choices are necessarily limited. The chance that the house will be completely compatible with

the needs and lifestyle of the family are remote. Thus, a low level of participation leads to decreased compatibility (Figure II-3; 2.3).

The perceived attributes, then, will effect how homeowners deal with malfunctions. As with any new technology, problems are apt to occur for both the owner-built and spec-built house but how the problems are dealt with may differ. If there are no problems, the owner-built homeowners would have a high level of satisfaction but this situation is very unusual. Even conventional custom-built homes exhibit some problems after the homeowners move in. The high design/build participation, though, enables the homeowners to use a number of options to alleviate the problem.

No matter what the problem is, a behavioral adaptation occurs (Figure II-2; 4.1). A thorough working knowledge of the system may enable the owner-builder to implement a simple technological solution, such as installing a ceiling fan to increase heat circulation from warmer areas of the house to cooler areas (winter mode). Another behavioral adaptation is through interior design. The dwellers might install a large number of plants or indoor trees to reduce glare (McLain and Langdon, 1983); or, they may use clothing to reduce thermal discomfort as has been reported by Ross (1982) and Towle (1979). Another option that custom-built

homeowners may use to is to ignore the problem altogether. If the problem is small or essentially unsolvable, there is a strong impulse to conceptually minimize it thus reducing their dissonance as discussed earlier. In any case, the homeowners who participate in the design/building process have better potential to maximize their energy savings and thermal comfort (Figure II-2; 4.3). Combined with perceiving the increased relative advantage of their home, the high design/build participation homeowners should have a higher level of satisfaction (Figure II-2; 5.0).

This model of how the owner-builders deal with problems can be contrasted with that of the spec-built homeowners (Figure II-3). The increased perceived complexity and resultant poorer understanding of the passive system causes them to be less able to correct malfunctions. In the similar situation of overheating discussed before, the homeowners may simply try to get the builders to solve the problem. The spec-built dwellers, too, may use interior design to solve problems but perhaps ineffectively. They may close draperies over direct gain aperture or install rugs over the direct gain thermal mass floors, both actions resulting in reduced solar collection and lower energy savings. Lesser compatibility of the home with the homeowners' needs and lifestyle may also result in conflicts which lower energy savings. The spec-built

homeowners, too, would have less of a personal stake in minimizing the problem since they did not design or build the house themselves. They do not have to admit they made mistakes; the builder or designer would get the blame. At any rate, the spec-built homeowners may have less of an ability to correct malfunctions and this would result in lower energy savings or thermal comfort (Figure II-3; 4.3). Combined then with perceiving a lesser relative advantage of their spec-built home, these homeowners would have a lower level of satisfaction.

6. HYPOTHESES

The preceding discussion suggests that a distinguishing characteristic of early adopters is that they have a high level of participation in the design and/or building process. Thus, innovation-adoption theory as well as the models depicted in Figures II-2 and II-3 can be used to generate a number of hypotheses regarding differences between passive solar homeowners who participate extensively in the design and building process and those who do not:

Hypothesis Regarding Perceived Complexity

1. High design/build participation homeowners will have a stronger understanding of the passive solar principles and the operation of their home than the low design/build participation homeowners.

Hypothesis Regarding Perceived Relative Advantage

2. High design/build participation homeowners will feel their house is a better investment and less of a financial risk than the low design/build participation homeowners.

Hypotheses Regarding Perceived Compatibility With Needs, Values, and Lifestyle

3. High design/build participation homeowners will feel their house is more compatible with their felt needs, values and lifestyle than low design/build participation homeowners.

4. High design/build participation homeowners will have higher postmaterialist values and lower materialist values than low design/build participation homeowners.

Hypotheses Regarding Behavioral Adaptation

5. High design/build participation homeowners will be willing to engage in more energy-conserving behaviors than low design/build participation homeowners.

6. High design/build participation homeowners will use more effective clothing and interior design management to conserve energy when adapting to passive system problems.

7. High design/build participation homeowners will be more consistent and be more involved in performing maintenance.

nance activities than low design/build participation homeowners.

8. High design/build participation homeowners will have a higher number of voluntary simplicity behaviors than low design/build participation homeowners.

Hypotheses Regarding Characteristics

9. High design/build participation homeowners will have a higher number of innovative behaviors than low design/build participation homeowners.

10. High design/build participation homeowners will have a higher number of opinion leadership activities than low design/build participation homeowners.

Hypothesis Regarding Satisfaction

Because of the above hypothesis regarding behavioral adaptation and perceived compatibility, the following hypothesis regarding satisfaction should hold true:

11. High design/build participation homeowners will have a higher satisfaction level with their home than the low design/build participation homeowners.

7. SUMMARY

This chapter has laid the theoretical framework for the research. First, the chapter examined the research on

characteristics of adopter categories which strongly indicates that present day owners fit the early adopter category. In addition, the discussion on innovation attributes indicates that early adopters may differ in their perception of passive solar. This perception was explored in detail by examining the perceived attributes, i.e. complexity, relative advantage, and compatibility. The perceived attributes also varied depending upon the individual's stage in the passive solar decision process. Furthermore, perceived attributes were found to be significantly affected by user participation, the variable differentiating the two groups in this study. A conceptual model predicted the behavioral adaptation and satisfaction process of the owner-built and spec-built homeowners. Finally, hypotheses were presented at the end of this chapter.

CHAPTER III

METHOD

The nature of the hypotheses presented in Chapter 2 necessitated multiple research methods of interview, survey, and observation. A discussion of these methods is presented in this chapter. The chapter begins with a general discussion of the method and description of the sample. Next, each hypothesis is listed with the relevant operational definitions and items from the research instrument. The next section describes how the interview and observation schedule were used to answer questions related to design. Finally, methods of data analyses are presented.

1. GENERAL METHOD

A study of passive solar homes and homeowners was conducted during the spring and summer months of 1984. A total of forty-one homeowners participated. Nineteen homeowners were sent a self-administered survey and asked to return it in a self-addressed, stamped envelope. Of these, thirteen returned the survey. Another twenty-eight homeowners were contacted by phone to ascertain their willingness to participate in both the interview and survey. All of these homeowners consented to be

interviewed in their home. The self-administered survey was first given to the homeowner to fill out before the interview began. The investigator then interviewed the homeowners in their home regarding their attitudes and involvement with the house. The final data collection procedure for the interview participants was through observation. This included documenting the interior and exterior of the house with photographic slides and making field notes on a floor plan regarding furniture placement. Observation of physical traces was also done as evidence of behavior to verify the self-reports of the sample participants.

2. SAMPLE

The sample is composed of forty-one passive solar homeowners in the eastern and southwestern regions of Virginia, i.e. Blacksburg (9), Christiansburg (1), Radford (2), New Castle (1), Troutville (1), Roanoke/Salem (5), Ferrum (1), Hardy (1), Richmond (11), Virginia Beach (8), and Norfolk (2). A list of these homeowners was obtained from several sources including the Virginia Division of Emergency and Energy Services (state energy office) as well as through contacts in the local and state chapters of the American Solar Energy Society.

Passive system types were restricted to the following:

Direct gain. A direct gain is a passive system where the sunlight enters directly into the living space and is stored in the furnishings, floor, wall, and/or air space of the house.

Indirect gain. An indirect gain system is a passive system where the sunlight is occluded and stored in a wall of water or concrete.

Direct gain/indirect gain. A direct gain/indirect gain system is a combination of direct and indirect gain in the same house.

Direct gain/sunspace. A direct gain/sunspace is a combination of direct gain with an attached sunspace.

3. OPERATIONAL DEFINITIONS AND MEASURES

In order to facilitate the understanding of how the collected data corresponds to the hypotheses, each hypothesis is presented with the operational definitions and the corresponding measures from the research instrument. The research instrument consists of 1.) interview schedule (IS), 2.) self-administered survey (SA), and 3.) observation schedule (OS).

Hypothesis 1

High design/build participation homeowners will have a stronger understanding of the passive solar principles and the operation of their home than the low design/build participation homeowners.

Operational Definitions.

Design/build participation. This means the extent to which the homeowners participate in the design and/or building process. Such activities as selecting wall and floor finishes, designing or working with the designer on the floor plan and/or solar features, and contributing physical labor are all examples of design/build participation. These activities are coded on question 6 in the interview so that lower scores indicate low design/build participation and higher scores indicate high design/build participation.

Passive solar principles and operation of the home. Some basic principles are winter and summer sun angles, roof overhangs, thermal mass, etc. Operation would include how these features are included in this house and what the related homeowner tasks such as turning on a fan, operating movable insulation or insulating window treatments.

Measure.

Item 3 on the interview schedule (IS) asks the homeowners to describe the operation of their house. The interviewer will check off passive features with an asterisk that exist in the home but which the homeowners fail to mention. A higher number of asterisks may mean that homeowners have a lesser understanding of the operation of their home.

Hypothesis 2

High design/build participation homeowners will feel their house is a better investment and less of a financial risk than low design/ build participation homeowners.

Operational Definitions.

Better investment and less of a financial risk. The extent to which the homeowner will not lose money if the house was resold.

Measure.

A lower score on item 6 (SA) indicates a higher perceived relative advantage.

Hypothesis 3

High design/build participation homeowners will feel their house is more compatible with their felt needs,

values, and lifestyle than the low design/build participation homeowners.

Operational Definitions.

Needs. Needs can be either physiological or pertaining to the body (i.e. thermal or visual comfort) or psychological or pertaining to the mind (i.e. privacy, sunlight).

Values. Values are "enduring beliefs determining general standards of conduct, independent of specific situations" (Farhar-Pilgram and Unseld, 1982, p. 144).

Lifestyle: Lifestyle is the "daily expression of more fundamental values" (p. 143).

Measure.

A higher score on item 4 (SA) and a lower score on item 5 (SA) indicates higher perceived compatibility of the house with homeowner needs.

Hypothesis 4

High design/build participation homeowners will have higher postmaterialist and lower materialist values than low design/build participation homeowners.

Operational Definitions.

Materialist and postmaterialist values. These values are associated with lower order (materialist) or higher

order (postmaterialist) hierarchy of needs (Maslow, 1970). Materialist values have "an emphasis upon material well-being" while postmaterialist values have an emphasis upon "the quality of life" (Inglehart, 1977, p. 3). Desire for economic and physical security are examples of materialist values while conservation, self-sufficiency, and a desire to use renewable energy resources are examples of post-materialist values.

Measure.

Higher scores on items 1 and 3 (SA) indicate higher postmaterialist values of self-sufficiency and desire to use an energy renewable resource while a higher score on item 2 (SA) indicates a higher materialist value, i.e. economics.

Hypothesis 5

High design/build participation homeowners will be willing to engage in more energy conserving behaviors than low design/build participation homeowners.

Operational Definition.

Energy conserving behaviors. Any behavior which maximizes the energy savings potential of the passive solar system is considered to be energy conserving. For example,

when the solar collection area becomes too warm on a sunny winter day, a homeowner might take off some clothing or circulate extra heat to another part of the house rather than vent the heated air outside or close the draperies.

Measure.

A higher score on item 7 (SA) indicates the homeowner is more willing to conserve energy. The responses to items 13 through 16 on the interview schedule were added to get an index of the homeowner's willingness to conserve energy. These are weighted for level of energy conservation. In addition, the utility bills for the heating season for each house were totaled; and, from these, the number of BTU's (British Thermal Units) for auxiliary heating were calculated. This figure was then divided by the square footage of the house and the heating degree days for 1983-84 to get an index of energy consumption. This is item 29a on the interview schedule. Item 2 on the observation schedule also has a list of physical traces or unobtrusive measures to give additional information on the homeowner's willingness to conserve energy.

Hypothesis 6

High design/build participation homeowners will use more effective clothing and interior design management to conserve energy when adapting to passive system problems.

Operational Definitions.

Effective clothing and interior design management.

Use of clothing, furnishings, or furniture arrangement to adapt to passive system and to conserve energy. Example: A homeowner may wear a T-shirt and short pants on winter days in the direct gain living room to keep cool. The same homeowner may wear sunglasses and rearrange seating to face away from the direct gain windows in order to reduce discomfort from glare. Effective interior design management include: higher reflectances for non-mass surfaces such as walls, ceilings, or furniture; a large number of house-plants; arrangement of seating to face away from south window area; or putting on sunglasses. An example of a negative interior design action includes clothing the draperies or window treatments to avoid glare during a winter day.

Glare. Glare causes visual discomfort which results from an imbalance of lighting levels or light reflections. Types of glare include discomfort glare (muscle spasm caused by rapid movement of the iris due to looking from light surface to dark surface), disability glare (visual acuity impaired because of stray light scattered over retina), and reflected or specular glare (reflective surfaces bounce light to eyes).

Thermal discomfort. Thermal discomfort is a state in which the person feels too warm or too cold to be comfortable.

Measure.

Items in the interview schedule (IS) ask what actions the homeowners take to adapt to thermal discomfort (items 13-16) or glare (item 16). These items are weighted and were added to achieve an index of effective interior design or clothing management. In addition, the observation schedule (OS) has a checklist for effective interior design to optimize the energy savings of the passive direct gain system. These interior design measures are those recommended by many interior design researchers (Guerin, 1980; Kachadorian, 1980; Breen, 1981; McLain and Langdon, 1983). In addition, evidence of use of clothing to be energy-efficient were observed and noted (Item 3 - OS).

Hypothesis 7

High design/build participation homeowners will be more consistent and be more involved in performing maintenance tasks or activities than low design/build homeowners.

Operational Definition.

Maintenance task. Any task or action which must be performed by the homeowners for the passive system to operate efficiently is considered a maintenance task. This includes such actions as opening and closing movable insulation, applying shading devices in summer, cleaning windows, and operating vents or fans.

Measure.

A lower score on item 12 (SA) and a higher score on item 13 (SA) indicates the homeowners perceive that they are more consistent in performing maintenance tasks. Item 7a (IS) documents the homeowners' level of involvement with maintenance tasks with the passive solar home. Item 4 (OS) is a checklist for observation of involvement with maintenance tasks.

Hypothesis 8

High design/build participation homeowners will have a higher number of voluntary simplicity behaviors than low design/build participation homeowners.

Operational Definition.

Voluntary simplicity behaviors. (Leonard-Barton, 1979)
Set of behaviors with the objective of decreasing material

consumption are voluntary simplicity behaviors. Examples of these behaviors include bicycling, recycling materials, self-sufficiency activities, and energy conservation.

Measure.

Questions 23 through 28 (SA) were modified from Farhar-Pilgrim and Unseld's (1982) survey instrument. The answers were coded and added for an index of voluntary simplicity behaviors. In addition, item 5 (OS) is a checklist for observing evidence of these behaviors. These behaviors are weighted.

Hypothesis 9

High design/build participation homeowners will have a higher number of innovative behaviors than low design/build participation homeowners.

Operational Definition.

Innovative behaviors. Innovative behaviors indicates a willingness to try something new or new technology such as home computers, microwave ovens, etc.

Measure.

Question 18 (SA) was modified from Farhar-Pilgrim and Unseld's (1982) survey instrument. Higher scores on this measure and item 15 (SA) indicate higher innovativeness.

Hypothesis 10

High design/build participation homeowners will have a higher number of opinion leadership activities than low design/build participation homeowners.

Operational Definition.

Opinion leadership. Opinion leadership is the degree to which a person influences opinion of others in their peer groups. Examples include being an officer in an organization, making speeches, writing letters to editor, etc.

Measure.

Question 19 (SA) was taken from Farhar-Pilgrim and Unseld's survey instrument (1982). The answers were weighted and added to get the number of opinion leadership activities the homeowner has engaged in in the past year.

Hypothesis 11

High design/build participation homeowners will have a higher satisfaction level with their home than the low design/build participation homeowners.

Operational Definition.

Satisfaction. Satisfaction means fulfillment of a desire or need.

Measures.

The Housing Satisfaction Scale (SA) was modified from Beamish's (1983) survey instrument. The original instrument contained 80 items and was developed for the Southern Regional Housing S-141 Research Project "Housing for Low and Moderate Income Families". Only 28 items specifically relating to design features were used in this study. They were added to achieve an index of overall satisfaction with housing features.

Another measure of general satisfaction includes question 28 (IS) which asks the homeowners to rate their home on a scale of 1 to 10. A higher rating indicates higher satisfaction. A higher score on item 11 (SA) also indicates higher overall satisfaction with the home.

Other measures in the research instrument are an indication of satisfaction with specific housing features. As mentioned before, the Housing Satisfaction Scale rates the homeowner's satisfaction with 28 specific features. Higher scores on items 8 and 9 (SA) indicate higher satisfaction with thermal comfort. A higher score on item 10 (SA) indicates higher satisfaction with energy savings.

Satisfaction with energy savings was also measured in question 29b (IS) which asks the homeowners to rate their satisfaction with their heating bills during the past winter. A higher score on item 7 (IS) indicates a higher level of satisfaction with woodstove operation. A higher score on item 14 (SA) and on items 17 through 20 (IS) indicate higher satisfaction with sunlight in the home.

4. DESIGN QUESTIONS

In addition to supporting or refuting the hypotheses listed above, the data will be used to give feedback to designers and interior designers of passive solar homes. Accordingly, the following exploratory questions were used to guide this part of the study and data collection:

1.) Are there particular floor plans that facilitate furniture arrangement in the direct gain house?

The combination of open plan with south wall window area reduces wall space which, in turn, may inhibit furniture arrangement. Question 10 (IS) asked the homeowners if they have had any difficulty in arranging furniture in any room in the house. The answer to this question along with an analysis of furniture arrangement in the homes indicated whether this was a problem and provided possible solutions.

2.) How is television-viewing affected by the direct gain system?

Homeowners were asked about the location of television-viewing activities and if south wall causes veiling reflections or other glare discomfort (question 21 on the interview schedule). In addition, photographs were taken of homeowner adaptations to this problem.

5. ANALYTICAL TECHNIQUES

General Techniques

Scores were assigned to each response on Likert-type items 1-15 on the self-administered survey (SA) as follows: 1=strongly disagree, 2=disagree, 3=neutral, 4=agree, 5=strongly disagree. Other data collected were scored as described in the previous discussion of measures.

Responses to all items were coded, transferred to the computer, and verified for accuracy.

Correlation Measure.

The nonparametric statistical test, Kendall's rank correlation coefficient (τ), was used as a measure of correlation between the independent variable, design/build participation, and other dependent variables. According to Siegel (1956), ". . . if at least ordinal measurement of both X and Y, then (Kendall's τ) will give a measure of the degree of association or correlation between two sets

of ranks (p. 213). The range of the correlation coefficient is between -1 to +1. The rule of thumb for interpreting the size of a correlation coefficient is:

.90 to 1.00	Very high positive correlation.
-.90 to -1.00	Very high negative correlation.
.70 to .90	High positive correlation.
-.70 to -.90	High negative correlation.
.50 to .70	Moderate positive correlation.
-.50 to -.70	Moderate negative correlation.
.30 to .50	Low positive correlation.
-.30 to -.50	Low negative correlation.
.00 to .30	Little, if any, correlation.
-.00 to -.30	Little, if any, correlation.

(from Applied Statistics for the Behavioral Sciences,
Hinkle, Wiersma, and Jurs, 1979)

The alpha or level of significance was set at .05. Kendall's tau was computed as specified in SAS (SAS Institute, 1982). Design/build participation was tested for correlation with the dependent variables as listed on Tables III-1 and III-2. These tables contain the hypotheses and the relevant dependent variables. However, other statistical tests were conducted on demographic variables and data relevant to the design questions.

Wilcoxon Rank Sum Test.

The Wilcoxon Rank Sum test is the non-parametric equivalent statistical test to the t test. For this analysis, homeowners who scored one or less on the design/build participation measure were placed in the low participation group while homeowners who scored two or above were placed in the high participation group. The

TABLE III-1

Variables and Measures for Hypotheses 2-8*

Hypothesis	Measure(s)	Variable Name
2	6 (SA)	Relative Advantage
3	4 (SA) 5 (SA)	Compatibility
4	1 (SA) 2 (SA) 3 (SA)	Self-sufficiency Economic Renewable Resource
5	7 (SA) 13-16 (IS) 29a (IS)	Energy Conservation
6	13-16 (IS) 2 (OS)	Interior Design and Clothing Management to Conserve Energy
7	12 (SA) 13 (SA) 7a (SA)	Consistency in Main- tenance Tasks Maintenance Involvement
8	23-28 (IS) 5 (OS)	Voluntary Simplicity

*SA=Self-Administered Survey
 IS=Interview Schedule
 OS=Observation Schedule
 HSS=Housing Satisfaction Scale

TABLE III-2

Variables and Measures for Hypotheses 9-11*

Hypothesis	Measure(s)	Variable Name
9	15 (SA) 18 (SA)	Innovativeness
10	19 (SA)	Opinion Leadership
11	HSS (SA) 11 (SA) 28 (IS)	Overall Satisfaction
	8 (SA) 9 (SA)	Satisfaction with Thermal Comfort
	7c (IS)	Satisfaction with Woodstove Operation
	8 (IS)	Satisfaction with Window Treatments
	10 (SA) 29b (IS)	Satisfaction with Energy Savings
	17-20 (IS) 14 (SA)	Satisfaction with Sunlight

*SA=Self-Administered Survey
 IS=Interview Schedule
 OS=Observation Schedule
 HSS=Housing Satisfaction Scale

Wilcoxon rank sum test was then performed for the same variables listed in Tables III-1 and III-2.

Homogeneity Test for Sample

A statistical test was conducted to ascertain whether the twenty-eight participants in the interview sample were homogeneous with the thirteen participants who were only given the self-administered survey or hereafter referred to as the "survey only" sample. The "survey only" sample was composed of twelve participants who had high participation and one participant who had low participation. Thus, the twelve homeowners with high design/build participation were compared with the fourteen homeowners in the interview sample who had high participation also. If these two groups were found to be homogeneous, then both sample groups would be considered to be homogeneous. The statistical mean was computed and the Wilcoxon Rank Sum Test, the two-sample nonparametric test for differences in central tendencies, was performed. All tests indicated that the two samples are homogeneous except:

Income. The "survey only" sample has a higher income range. Their average income was in the \$37,000 to \$45,000 range while the interview sample had an average income in the \$25,000 to \$35,000 range. Sum of rank scores for "survey only" sample was 177.5 while sum of rank scores for

interview sample was 122.5 ($p=.017$). One possible explanation for this finding is that more participants from the interview sample were from the southwestern part of the state which may have lower income. Sixteen of the interview sample were from the southwestern part of Virginia while only twelve were from the eastern part of Virginia. Only five of the "survey only" sample were from southwestern Virginia while eight participants were from eastern Virginia.

Age of household head: The average age of the head of the household in the "survey only" sample was 47 while the average age of the head of the household in the interview sample was 37. The explanation for this difference can readily be seen by examining the number of retired persons in each group. There are three retired persons or persons aged over 60 in the "survey only" sample while there is only one person over age 60 in the interview sample. In addition, there were more participants from the interview sample who were in the 25-30 age range.

The results showed that although the "sample only" group and the interview sample differed in age and income, all other tests indicated no differences on variables regarding values, lifestyle, and attitudes. Thus, the two groups are considered to be homogeneous for the purposes of this study.

CHAPTER IV

RESULTS

This chapter presents the results of the research. The first section details descriptive characteristics of the sample including demographic information on the participants as well as information on the passive systems. The second section is a report on the results of the statistical tests for each hypothesis. Finally, the last section is a discussion of the results relating to the design questions.

1. CHARACTERISTICS OF SAMPLE

Design/Build Participation

Participation in the design and/or building process is the independent variable differentiating the two groups in this study. Table IV-1 indicates the frequency distribution of the levels. Fifteen of the sample were classified as having low design/build participation. These either had no involvement or were able to select wall and/or floor finishes. Fourteen of these were in the interview sample. Twelve or 29% of the sample had high participation. These homeowners either worked with a designer on the floor plan and solar features or designed their house themselves. Almost 35% or 14 homeowners had very high participation.

Table IV-1
Frequency Distribution of
Design/Build Participation

Participation Level in House Design and Construction	Interview Sample Frequency (Percentage)	Survey Only Sample Frequency (Percentage)
LOW Had no involvement or selected wall and/or floor finishes or score equal to 0 or 1.	14 (34.1%)	1 (02.4%)
HIGH Designed floor plan or worked with designer and selected finishes or score equal to 3 to 5.	6 (14.6%)	6 (14.6%)
VERY HIGH Designed floor plan, selected finishes, and contributed physical labor or score equal to 6 to 7.	8 (20.0%)	6 (14.6%)

They designed their house plan, selected finishes, and contributed a large amount of physical labor to the building construction.

Demographic Variables

Table IV-2 contains information on the means for various demographic variables:

Age of household head: The average ages for the high and low participation groups were 42 and 33 respectively. The Wilcoxon rank sum test was performed and showed median differences in the two groups for the variable of age. The mean rank score was 24.4 for the high group and 13.25 for the low group ($p=.004$).

Number in household. The average number of persons in each household was 3.04 for the high group and 2.4 for the low group. The mean rank scores on the Wilcoxon rank sum test was 23.79 for the high group and 16.17 for the low group ($p=.036$).

Income. The average income for the high group was \$31,300 while it was \$33,600 for the low group. The difference in income was not significant according to the Wilcoxon rank sum test ($p=.937$). The Wilcoxon test was also performed on the two groups with participation at the highest level (six or seven) dropped out. This was done to see if very high participation might have a lowering effect

Table IV-2
Means for Age of Household Head,
Number in Household, Income,
and Education

Variable	Design/Build Participation*	
	High x	Low x
Age of Household Head	42	33
Number in Household	2.40	3.04
Average Income+	\$31,300**	\$33,600***
Average Income++ (dropping out very high participation)	\$40,999****	\$33,600***
Highest Educational Level+++	5.38	4.00

* n=26 for High Design/Build Participation Group and n=15 for Low Design/Build Participation Group except where indicated.

** n=24

*** n=14

**** n=12

+ Annual income ranged from \$25,000 to \$55,000 for the low group and \$13,500 to \$55,000 for the high group.

++ Annual income ranged from \$34,900 to \$55,000 for high group.

+++ Educational levels were: 1=less than high school, 2=high school graduate, 3=trade or technical school, 4=some college, 5=college graduate, and 6=graduate work or more.

on the mean income for the high group because these homeowners contributed physical labor in order to lower their construction costs. Although the mean income then rose to \$40,999 for the high group, the Wilcoxon rank sum test did not reveal a significant median difference between the two groups ($p=.121$).

Education. The average highest educational level achieved by the high design/build group was 5.38 where five indicated college graduate level and six indicated graduate work or more. In contrast, the average low design/build participation educational level was four which indicated the average homeowner had some college. The Wilcoxon rank sum test was performed and showed median differences in the two groups. The mean rank of the high group was 25.33 and 13.50 for the low group ($p=.001$).

House Characteristics

System Types

Table IV-3 is a frequency distribution of the types of systems by participation group and type of sample. A total of 27 or 66% of the sample were direct gain systems. The majority or 24 of the interview sample were direct gain while only three of the survey only sample were of this type. Only one house was an indirect gain system. This was a low design/build participation homeowner who had a

Table IV-3
Frequency Distribution of
Passive Solar System Types

System Type	Interview Sample Participation		Survey Only Sample Participation		Row Totals
	High	Low	High	Low	
Direct Gain	11	13	3		27
Indirect Gain		1			1
Direct Gain/ Indirect Gain	2		2		4
Direct Gain/ Sunspace	1		7	1	9
Column Totals	14	14	12	1	41

waterwall system. Two houses in the interview sample and two houses in the survey only sample had both direct gain and indirect gain systems. Finally, eight or 20% of the total sample had a direct gain and sunspace system.

Years Lived in House

The average number of years the low design/build group lived in their houses was 1.47 while the average number of years the high design/build group lived in their houses was 2.5.

House Square Footage

The average house square footage for the low participation house was 1627 while it was 2005 for the high group. The Wilcoxon rank sum test revealed that this was a significant median difference between the two groups ($p=.023$). For the interview sample only, the average square footage was 1654 ($n=14$) for the low group and 1832 for the high group ($n=14$). The Wilcoxon rank sum test indicated that this was not a significant median difference between the two groups ($p=.301$).

2. STATISTICAL TEST RESULTS OF HYPOTHESES

This section details the statistical results of the hypotheses. Although the tables give a summary of the results, it is helpful here to provide a brief overview.

Hypothesis two predicted that the high participation homeowners would feel their house had a higher relative advantage. This was not supported by the results. Likewise, hypothesis three predicted that the high group would feel their house is more compatible. This was also not supported by the results. According to hypothesis four, the high participation group should have lower materialist values and higher postmaterialist values. The results did indicate that the high group had lower economic values. However, no differences were found between the two groups on the postmaterialist values of self-sufficiency and desire to use renewable energy resources. According to hypothesis five, the high group should be more energy conserving. This was only partially supported. The interview item which was an index of energy conservation behaviors did indicate a difference between the two groups. Yet there was no difference between the two groups on the survey measure which asked the homeowner whether they agreed or disagreed with the statement that they were willing to go to a lot of trouble to save energy. The difference between the two groups on the energy conservation index or total number of Btu's (British Thermal Units) used for auxiliary heating was significant. Hypothesis six predicted that the high group would have more effective clothing and interior design management and this was

supported by the results. Hypothesis seven predicted that the high group would be more consistent with maintenance tasks. This was not supported but the high group were found to be involved in more maintenance tasks than the low group. According to hypothesis eight, the high group would engage in more voluntary simplicity behaviors than the low group. This was partially supported by the results.

Hypothesis nine predicted that the high group would be more innovative yet the findings did not support this hypothesis. The findings did indicate, however, that the high participation homeowners were more involved in opinion leadership activities in the past year as hypothesis ten predicted. Finally, hypothesis eleven concerned a major contention that the high group would have a higher level of satisfaction with their homes. This was supported by the finding that high participation homeowners had an overall higher level of satisfaction with their homes. However, there was no differences for the two groups on satisfaction levels with many individual housing features.

Tables IV-4, 5, 6, and 7 present a consise summary of the results of the statistical tests. Following is a detailed discussion by individual hypothesis of the findings.

Table IV-4

Correlation Between Design/Build Participation
and Selected Variables

Hypo-thesis	Measure*	Kendall's tau	Expected Direction	Hypothesis Supported	p-value
2	6 (SA)	.05	H < L	No	.684
3	4 (SA)	.16	H > L	No	.245
	5 (SA)	-.04	H < L	No	.737
4	1 (SA)	-.15	H > L	No	.264
	2 (SA)	-.26	H < L	No	.057
	3 (SA)	-.04	H > L	No	.731
5	7 (SA)	-.04	H > L	No	.971
	13-16 (IS)	.33	H > L	Yes	.040**
	29a (IS)	-.21	H < L	No	.128
6	13-16 (IS)	.33	H > L	Yes	.040**
	2 (OS)	.37	H > L	Yes	.029**
7	12 (SA)	-.04	H < L	No	.786
	13 (SA)	.14	H > L	No	.308
	7a (IS)	.46	H > L	Yes	.0001**
8	23-28 (SA)	.30	H > L	Yes	.002**
	5 (OS)	.44	H > L	Yes	.004**
9	15 (SA)	.14	H > L	No	.313
	18 (SA)	-.03	H > L	No	.818

*SA=Self-Administered Survey (n=26 for High Group, n=15 for Low Group).

IS=Interview Schedule (n=14 for High Group, n=14 for Low Group).

OS=Observation Schedule (n=14 for High Group, n=14 for Low Group).

HSS=Housing Satisfaction Scale

**p<.05 Significant

Table IV-5

Correlation Between Design/Build Participation
and Variables of Opinion Leadership and Satisfaction

Hypo-thesis	Measure*	Kendall's tau	Expected Direction	Hypothesis Supported	p-value
10	19 (SA)	.39	H > L	Yes	.001**
11	HSS (SA)	.27	H > L	Yes	.022**
	11 (SA)	.03	H > L	No	.801
	28 (IS)	.53	H > L	Yes	.001**
	8 (SA)	-.13	H > L	No	.350
	9 (SA)	-.18	H > L	No	.175
	7c (IS)+	.02	H > L	No	.927
	8 (IS)++	-.47	H > L	No	.076
	10 (SA)	-.16	H > L	No	.259
	29b (IS)	.29	H > L	Yes	.092
	17-20 (IS)	-.11	H > L	No	.506
	14 (SA)	.10	H > L	No	.445

*SA=Self-Administered Survey (n=26 for High Group, n=15 for Low Group).

IS=Interview Schedule (n=14 for High Group, n=14 for Low Group).

OS=Observation Schedule (n=14 for High Group, n=14 for Low Group).

HSS=Housing Satisfaction Scale

+n=9 for High Group, n=8 for Low Group.

++n=4 for High Group, n=9 for Low Group.

**p<.05 Significant

Table IV-6

Wilcoxon Rank Scores for High and Low
Design/Build Participation Groups
for Selected Variables

Hypo- thesis	Measure*	x		Mean Rank		Wilcoxon p-value	Exp. Dir.	Hypothesis Supported
		High	Low	High	Low			
2	6 (SA)	2.00	1.80	21.5	20.1	.704	H < L	No
3	4 (SA)	4.58	4.20	23.2	17.1	.076	H > L	No
	5 (SA)	2.27	2.73	19.0	24.4	.147	H < L	No
4	1 (SA)	3.73	4.13	19.4	23.8	.223	H > L	No
	2 (SA)	4.27	4.67	18.4	25.5	.041**	H < L	Yes
	3 (SA)	4.19	4.07	22.0	19.2	.441	H > L	No
5	7 (SA)	3.69	3.73	21.0	20.9	.999	H > L	No
	13-16 (IS)	4.07	2.08	15.4	10.4	.08	H > L	No
	29a (IS)	3102	4787	11.4	17.6	.05**	H < K	Yes
6	13-16 (IS)	4.07	2.08	15.4	10.4	.08	H > L	No
	2 (OS)	3.79	3.08	16.2	10.3	.033**	H > L	Yes
7	12 (SA)	2.04	2.27	18.7	22.0	.334	H < L	No
	13 (SA)	3.88	3.33	23.1	15.1	.021**	H > L	Yes
	7a (IS)	4.42	2.06	24.9	14.2	.005**	H > L	Yes
8	23-28 (SA)	9.07	7.93	22.9	17.6	.165	H > L	No
	5 (OS)	1.46	0.33	16.3	10.3	.036**	H > L	Yes
9	15 (SA)	4.54	4.47	21.8	19.6	.526	H > L	No
	18 (SA)	1.33	1.33	19.8	20.3	.917	H > L	No

*SA=Self-Administered Survey (n=26 for High Group, n=15 for Low Group).

IS=Interview Schedule (n=14 for High Group, n=14 for Low Group).

OS=Observation Schedule (n=14 for High Group, n=14 for Low Group).

HSS=Housing Satisfaction Scale

**p<.05 Significant

Table IV-7

Wilcoxon Rank Scores for High and Low Design/Build
Participation Groups for Opinion Leadership
and Satisfaction

Hypo-thesis	Measure*	x		Mean Rank		Wilcoxon p-value	Exp. Dir.	Hypothesis Supported
		High	Low	High	Low			
10	19 (SA)	4.36	1.80	25.2	12.7	.001**	H > L	Yes
11	HSS (SA)	148	120	24.5	13.9	.006**	H > L	Yes
	11 (SA)	4.62	4.40	22.6	18.2	.194	H > L	No
	28 (IS)	8.93	7.64	19.3	9.8	.001**	H > L	Yes
	8 (SA)	4.20	4.27	19.9	21.5	.602	H > L	No
	9 (SA)	3.88	4.07	19.6	21.9	.506	H > L	No
	7c (IS)+	4.00	3.88	9.2	8.8	.919	H > L	No
	8 (IS)++	4.5	4.78	5.8	7.6	.387	H > L	No
	10 (SA)	4.41	4.53	18.4	22.5	.216	H > L	No
	29b (IS)	4.77	4.42	14.5	11.4	.189	H > L	No
	17-20 (IS)	3.64	4.08	12.5	14.8	.403	H > L	No
	14 (SA)	4.62	4.73	20.5	21.8	.695	H > L	No

*SA=Self-Administered Survey (n=26 for High Group, n=15 for Low Group).

IS=Interview Schedule (n=14 for High Group, n=14 for Low Group).

OS=Observation Schedule (n=14 for High Group, n=14 for Low Group).

HSS=Housing Satisfaction Scale

**p<.05 Significant.

+n=9 for High Group, n=8 for Low Group.

++n=4 for High Group, n=9 for Low Group.

Hypothesis 2

"High design/build participation homeowners will feel their house is a better investment and less of a financial risk than low design/build participation homeowners."

This hypothesis was not supported. The mean score on item six on the self-administered survey for the high group was 2.00 while it was 1.80 for the low group where one indicated that the respondent strongly disagreed with the statement: "Sometimes we worry that we may lose money if we were to sell our house". The mean rank scores for the high and low groups were 21.5 and 20.1 respectively. The Wilcoxon rank sum test indicated that there was not a significant median difference ($p=.704$). The correlation coefficient was .05 indicating no correlation between participation and perceived relative advantage ($p=.684$).

Hypothesis 3

"High design/build participation homeowners will feel their house is more compatible with their felt needs, values, and lifestyle than the low design/build participation homeowners."

This hypothesis was not supported by the results. The mean score for item four on the self-administered survey for the high group was 4.58 while it was 4.20 for the low group. A score of four indicated that the homeowner agreed

with the statement: "Our home is compatible with the way we live." The Wilcoxon rank sum test did not indicate a significant median difference between the two scores. The mean rank scores for the high and low groups were 23.2 and 17.1 respectively ($p=.076$). The correlation coefficient was .16 indicating no significant correlation between perceived compatibility and design/build participation ($p=.245$) according to this measure.

Item five on the self-administered survey asked the homeowner to indicate whether they agreed with the statement, "If we were to buy another house, it would be different from this one." The mean rank scores for the high and low groups were 19 and 24.4 respectively. The mean score for the high group was 2.27 while the score for the low group was 2.73. This was not a significant difference according to the Wilcoxon rank sum test ($p=.147$). The correlation coefficient was $-.04$ indicating no correlation between perceived compatibility and participation ($p=.737$).

Hypothesis 4

"High design/build participation homeowners will have higher postmaterialist and lower materialist values than low design/build participation homeowners."

The results indicate that high design/build participation homeowners have lower economic values (a materialist

value). Item two on the self-administered survey asks the homeowners to indicate whether they agree with the statement: "Saving money is very important to us." The mean scores for the high and low groups were 4.27 and 4.67 respectively. The Wilcoxon rank sum test showed median differences between the two groups ($p=.041$). The correlation coefficient or Kendall's tau was $-.25$ indicating a small negative correlation between participation and economic values which was not significant ($p=.057$).

Postmaterialist values were measured by items one and three on the self-administered survey. Homeowners were asked to indicate whether they agreed with the statements "Self-sufficiency is an important goal for our family" and "Using a renewable energy resource instead of fossil fuels is an important goal for our family."

The mean score for item one or the self-sufficiency measure was 3.73 for the high group and 4.13 for the low group. The mean rank scores were 19.4 for the high group and 23.8 for the low group ($p=.223$). The correlation coefficient was $-.15$ indicating little or no negative correlation between design/build participation and self-sufficiency or postmaterialist values ($p=.264$).

The results were similar for item three on the self-administered survey which measured the homeowner's desire

to use renewable energy resources. The mean score was 4.19 for the high group and 4.07 for the low group. The mean rank scores for the high and low groups were 22 and 19.2 respectively. The Wilcoxon rank sum test did not reveal a significant median difference between the two groups ($p=.441$). The correlation coefficient was $-.04$ indicating no correlation between desire to use renewable energy resource or this postmaterialist value and participation.

Hypothesis 5

"High design/build participation homeowners will be willing to engage in more energy conserving behaviors than low design/build participation homeowners."

Item seven from the survey asks the homeowners whether they agree with the statement, "We are willing to go to a lot of trouble to conserve energy." This measure failed to support the hypothesis. The mean scores were 3.69 for the high group and 3.73 for the low group. The Wilcoxon rank sum test failed to indicate significant median differences between the two groups ($p=.999$). Likewise, Kendall's was computed as $-.04$ indicating no correlation ($p=.971$).

The results from the interview (items 13-16) indicates a relationship between design/build participation and energy conserving behaviors. The mean scores for the high and low groups were 4.07 and 2.08 respectively. The

correlation coefficient or Kendall's tau was .33 ($p=.04$) indicating a low to moderate correlation between design/build participation and energy conserving behaviors. However, the Wilcoxon rank sum test failed to indicate a significant median difference between the two groups ($p=.08$).

The energy consumption index showed a difference between the two groups. This index was calculated by taking the total auxiliary heating used in BTU's (British Thermal Units) divided by the square footage and the normal heating degree days (Balcomb, 1982) for that area. This gives a number equal to the number of BTU's consumed per day per square foot of house for the winter heating season. The average index was 3102 for the high group and 4781 for the low group. The Wilcoxon rank sum test revealed a median difference between the two groups ($p=.051$). The correlation coefficient was $-.217$ which was not significant ($p=.128$).

Hypothesis 6

"High design/build participation homeowners will use more effective clothing and interior design management to conserve energy when adapting to passive system problems."

The results from the interview (items 13-16) only partially supported this hypothesis. Kendall's tau was .33

indicating a low to moderate correlation ($p=.04$). The average scores for the high and low groups were 4.07 and 2.08 respectively. The mean rank score for the high group was 15.4 while the mean rank score for the low group was 10.4. However, this was not a significant median difference between the two groups ($p=.08$).

The results from item 3 of the observation schedule supported the hypothesis. The mean scores for the high and low groups were 3.79 and 3.08 respectively. The Wilcoxon rank sum test revealed a significant median difference between the two groups ($p=.033$).

Hypothesis 7

"High design/build participation homeowners will be more consistent and be more involved in performing maintenance tasks or activities than low design/build participation homeowners."

It was expected that the high design/build homeowners would score lower on item 12 and higher on item 13 on the self-administered survey. These items were designed to measure the homeowners' perceived consistency in performing maintenance tasks. The mean scores on item 12 were 2.04 and 2.27 for the high and low groups respectively. This difference was not significant according to the Wilcoxon rank sum test ($p=.334$). Likewise, Kendall's tau was $-.04$

indicating no correlation between perceived consistency and participation ($p=.786$). The mean scores for item 13 were 3.88 for the high group and 3.33 for the low group. The mean rank scores were 23.1 and 15.1 respectively for the high and low groups. This was a significant median difference according to the Wilcoxon rank sum test ($p=.021$). However, Kendall's tau was .14 but this was not significant ($p=.308$).

The results from item 7 on the interview schedule indicate that the high participation homeowners were more involved with maintenance tasks such as operation of movable insulation or the woodstove. The mean scores were 4.42 for the high group and 2.06 for the low group. The mean rank sum score for the high group was 24.9 and 14.2 for the low group. The Wilcoxon rank sum test revealed a significant difference between the levels of maintenance involvement for the two groups ($p=.005$). Kendall's tau or the correlation coefficient was .46 indicating a significant moderate correlation between maintenance task involvement and design/build participation ($p=.0001$).

Hypothesis 8

"High design/build participation homeowners will have a higher number of voluntary simplicity behaviors than low design/build participation homeowners."

The mean score for the index of voluntary simplicity behaviors (items 23 through 28 on the survey) was 9.07 for the high group and 7.93 for the low group. The mean rank scores were 22.9 and 17.6 for the high and low groups respectively. The Wilcoxon rank sum test indicates that this median difference was not significant ($p=.165$). Kendall's tau or the correlation coefficient was .30 indicating a low positive correlation between voluntary simplicity behavior and design/build participation ($p=.002$).

Table IV-8 lists the individual items in the voluntary simplicity behaviors index. On item 23 which measured bicycling, the low design/build participation group scored higher. The mean was 1.47 for the low group while it was .77 for the high group. The Wilcoxon rank sum test was significant ($p\text{-value}=.050$). On item 24 which measured recycling, the high group scored higher. The mean was 1.77 for the high group while it was .87 for the low group. This difference was significant according to the Wilcoxon rank sum test ($p=.015$). The other individual items did not show a significant median difference between the two groups according to the Wilcoxon test.

The measure from the observation schedule supported this hypothesis. This item measured the number of observations of voluntary simplicity behaviors for each group.

Table IV-8

Means For High and Low Design/Build
Participation Groups for
Voluntary Simplicity Behaviors

Self-Administered Survey Item	Design/Build Participation*		Wilcoxon p-value
	High x	Low x	
23-28. Index of Voluntary Simplicity Behaviors	9.08	7.93	.165
23. Bicycling	.77	1.47	.050**
24. Recycling	1.77	.87	.015**
25. Self-reliance Skills	2.31	1.87	.173
26. Buying Used Clothing	.58	.33	.357
27. Contributing to Ecolo- gical Organizations	1.69	1.20	.236
28. Physical Exercise	1.96	2.20	.352

* n=26 for High Design/Build Participation Group and n=15
for Low Design/Build Participation Group.

** p<.05 Significant

The mean scores were 1.46 for the high group and .33 for the low group. The mean rank scores for the high and low groups were 16.3 and 10.3 respectively. The Wilcoxon rank sum test revealed a significant median difference between the two groups ($p=.036$). The correlation coefficient or Kendall's tau of .44 indicates a moderate positive correlation between observations of voluntary simplicity behaviors and design/build participation ($p=.006$).

Hypothesis 9

"High design/build participation homeowners will have a higher number of innovative behaviors than low design/build participation homeowners."

The hypothesis was not supported by the results. The mean score on item 15 on the self-administered survey was 4.54 for the high group and 4.47 for the low group. This item asked the homeowners to indicate whether they agreed with the statement, "New ideas are very exciting to me." Kendall's tau for this measure of innovativeness was .14 which indicates little if any correlation ($p=.313$).

Item 18 on the self-administered survey asked the homeowner to check the number of innovative technology items that the family owned. The average number owned by both groups of homeowners was 1.33. Kendall's tau was $-.03$ indicating no correlation between number of innovative

technology items owned and design/build participation ($p=.818$) Similarly, the results from the Wilcoxon rank sum test indicated that there was no median difference between the two groups. The mean rank score for the high group was 19.8 and 20.3 for the low group ($p=.917$).

Hypothesis 10

"High design/build participation homeowners will have a higher number of opinion leadership activities than low design/build participation homeowners."

Item 19 on the self-administered survey is a measure of the number of opinion leadership activities that the homeowner engaged in during the last year. The mean score on item 19 was 4.36 for the high group and 1.80 for the low group. The mean rank score for the high group was 24.9 and 13.1 for the low group which indicates a significant median difference between the two groups ($p=.001$). The correlation coefficient was .39 indicating a low to moderate correlation between opinion leadership activities and design/build participation ($p=.001$).

Hypothesis 11

"High design/build participation homeowners will have a higher satisfaction level with their home than low design/build participation homeowners."

There were a number of measures of satisfaction in the study:

Overall Housing Satisfaction

Housing Satisfaction Scale. The total score on the Housing Satisfaction Scale was an index of the overall satisfaction with housing features. The mean score for the high group was 148 and 120 for the low group. Kendall's tau was .27 indicating a low correlation between satisfaction and design/build participation ($p=.001$). The Wilcoxon rank sum test indicated a median difference between the two groups. The mean rank scores for the high group and low groups were 24.9 and 13.9 respectively ($p=.006$). Thus, this measure supported this hypothesis.

Individual and Group Housing Satisfaction Scale Items. Tables IV-9 and IV-10 list the means and Wilcoxon p-values for individual and group items on the Housing Satisfaction Scale. On all items, the high design/build participation group scored higher on satisfaction level. However, only the following twelve individual items out of a total of twenty-eight were statistically significant:

1. Number of rooms.
2. Arrangement of rooms.
3. Storage for cleaning equipment and supplies.
4. Storage space in bath.
5. Living room--size of living area.
6. Dining--size of dining space.
7. Dining--location of dining area(s).
8. Dining--flexibility of arranging furniture.

Table IV-9

Means for High and Low Design/Build
Participation Groups for Layout, Storage, and
Living Room on Housing Satisfaction Scale

Housing Satisfaction Scale Item	Design/Build Participation*		Wilcoxon p-value
	High x	Low x	
1. Layout of Floor Plan (1a-1d):	5.12	4.45	.044*
a. Privacy for family members.	5.04	4.53	.317
b. Separation of children and parent areas.	5.00	4.27	.175
c. Number of rooms.	5.19	4.53	.045*
d. Arrangement of rooms.	5.23	4.47	.036*
2. Storage (2a-2f):	4.80	4.01	.013*
a. Closet space in master bedroom.	4.88	4.27	.161
b. Closet space in other bedrooms.	4.73	4.20	.125
c. Storage for household linens.	4.88	4.47	.127
d. Storage for cleaning equipment and supplies.	4.88	3.47	.006*
e. Storage at entry.	4.62	3.73	.153
f. Storage space in bath.	4.88	4.13	.037*
3. Living Room (3a-3c):	5.08	3.93	.023*
a. Flexibility in arrange- ment of furniture.	4.54	3.60	.086
b. Size of living area.	5.42	3.80	.001*
c. Floor coverings.	5.08	4.40	.235

*p<.05 Significant

Table IV-10

Means for High and Low Design/Build
Participation Groups for Dining, Kitchen,
Bedrooms, and Bath on Housing Satisfaction Scale

Housing Satisfaction Scale Item	Design/Build Participation*		Wilcoxon p-value
	High x	Low x	
4. Dining (4a-4d):	5.42	4.35	.010*
a. Size of dining space.	5.50	4.20	.001*
b. Location of dining area(s).	5.58	4.60	.004*
c. Floor coverings.	5.23	4.73	.227
d. Flexibility of furn- iture arrangement.	5.38	3.87	.008*
5. Kitchen (5a-5c):	5.56	4.24	.003*
a. Amount of counter space.	5.65	4.60	.027*
b. Amount of storage space.	5.46	3.73	.002*
c. Arrangement of work space.	5.46	4.40	.012*
6. Bedrooms (6a-6e):	5.15	4.75	.070
a. Number of bedrooms.	5.15	4.80	.258
b. Flexibility in arrang- ing furniture in master bedroom.	5.15	4.53	.073
c. Flexibility in arrang- furniture in other bedrooms.	4.96	4.40	.144
d. Size of master bed- room.	5.46	4.80	.012*
e. Size of other bed- rooms.	4.96	4.47	.080
7. Bath (7a-7c):	5.23	4.96	.461
a. Number of bathrooms.	5.58	5.13	.221
b. Size of bathrooms.	4.96	4.80	.549
c. Arrangement of bathroom fixtures.	5.08	4.93	.718

*p<.05 Significant

9. Kitchen--amount of counter space.
10. Kitchen--amount of storage space.
11. Kitchen--arrangement of work space.
12. Bedrooms--size of master bedroom.

Individual items were added for each section or group. Of these, the following means for the two groups were found to be statistically significant: layout of floor plan, storage, living room, dining, and kitchen.

Other Overall Satisfaction Measures. Item 11 on the self-administered survey asks the homeowners to indicate how strongly they agree or disagree with the statement "We are very happy with our home." The mean scores for the high and low groups were 4.61 and 4.40 respectively. The Wilcoxon rank sum test did not indicate a significant median difference between the two groups ($p=.194$). Kendall's tau of .03 indicates no correlation between satisfaction and participation ($p=.801$).

Item 28 from the interview schedule asked the homeowners to rate their home on a scale of one to ten, ten meaning that they were highly satisfied with their home. The mean scores were 8.93 and 7.64 for the high and low groups respectively. Kendall's tau of .53 indicates a moderate correlation between overall housing satisfaction and design/build participation ($p=.001$) The mean rank scores for the high and low groups were 19.3 and 9.8 respectively. The Wilcoxon rank sum test indicated a

significant median difference between the two groups ($p=.001$). This result supports the hypothesis.

Overall Satisfaction and Square Footage

Many of the individual items that had significant median differences on the Housing Satisfaction Scale seemed to be associated with size or scale (i.e. size of dining area, master bedroom, living area, etc.). Thus, a test for correlation between satisfaction and square footage was conducted to see if this may have contributed to the differences in satisfaction. Kendall's tau for the Housing Satisfaction Scale and square footage of house was .19 indicating a low but not significant correlation ($p=.076$). The correlation coefficient for item 28 on the interview schedule which had the homeowners rank their satisfaction on a scale of 1 to 10 was .07 which indicates no correlation between square footage and satisfaction ($p=.658$).

Overall Satisfaction and Demographic Variables

Table IV-11 is a matrix of the correlation coefficients or Kendall's tau for the demographic variables and housing satisfaction. Housing satisfaction and participation were found to be correlated (Kendall's tau=.53). However, Siegel (1956) cautions: "When correlation is observed between two variables, there is always the

Table IV-11
Correlation Matrix for Age, Income, Education,
and Housing Satisfaction

	Age	Income	Education	Partici- pation	Housing Satisfac- tion*
Age	-	.37	.28	.09	.01
Income	-	-	.23	-.16	-.07
Education	-	-	-	.33	.33
Participation	-	-	-	-	.53

*Item 28 on interview schedule.

possibility that this correlation is due to the association between each of the two variables and a third variable." He notes that "this problem may be attacked by methods of partial correlation (p. 223)." Thus, partial rank correlation coefficients were calculated for housing satisfaction and participation controlling for the variables of age, income, and education. The partial rank correlation coefficient for satisfaction and participation when age is partialled out remained .53. Likewise, when income is partialled out, the correlation between satisfaction and participation was .53. Finally, the partial rank correlation coefficient for satisfaction and participation controlling for education was .50. Since these values are equal or only slightly smaller than the zero order correlation between housing satisfaction and participation of .53, it can be concluded that this relation is relatively independent of the influence of age, income, and education.

Satisfaction with Specific Housing Features

Satisfaction with winter thermal comfort. The mean scores for item 8 on the survey were 4.20 and 4.27 for the high and low groups respectively. Kendall's tau was $-.13$ indicating no correlation ($p=.350$). The mean rank scores for the high and low groups were 19.9 and 21.5 respectively

indicating little median differences between the two groups ($p=.602$).

Satisfaction with summer thermal comfort. The mean scores for item 9 on the survey were 3.88 and 4.07 for the low and high groups respectively. This was not a significant difference according to the Wilcoxon rank sum test ($p=.506$). Kendall's tau was $-.18$ indicating no significant correlation between participation and satisfaction with summer thermal comfort ($p=.175$).

Satisfaction with woodstove involvement. Item 7c on the interview schedule asked the homeowners to rate their satisfaction with operating the woodstove on a scale of 1 to 5. The mean scores for the high and low groups were 4.00 and 4.07 respectively. This was not a significant median difference according to the Wilcoxon rank sum test ($p=.919$). Kendall's tau was $.02$ indicating no correlation ($p=.927$).

Satisfaction with window treatments. The mean scores for item 8 on the interview schedule were 4.5 and 4.78 for the high and low groups respectively. This was not a significant difference according to the Wilcoxon rank sum test ($p=.387$). Kendall's tau was $-.47$ indicating some correlation but the statistical test was not significant ($p=.071$).

Satisfaction with energy savings. Item 10 on the survey was a measure of the homeowner's satisfaction with

energy savings. The mean scores were 4.41 for the high group and 4.53 for the low group. The mean rank scores were 18.4 for the high group and 22.5 for the low group. The Wilcoxon rank sum test failed to show a significant median difference between the two groups ($p=.216$). Kendall's tau was $-.16$ indicating no significant correlation between energy savings satisfaction and participation ($p=.259$).

The measure from the interview schedule also did not show a significant difference between the satisfaction ratings of energy savings for the two groups. The mean scores on item 29b from the interview schedule were 4.72 and 4.42 for the high and low groups respectively. The Wilcoxon rank sum test failed to indicate a median difference between the two groups ($p=.189$). Kendall's tau was $.29$ indicating no significant correlation between energy savings satisfaction and participation ($p=.09$).

Satisfaction with Sunlight. Items 17 through 20 on the interview schedule were added to get an index of satisfaction with sunlight. The mean scores for the high and low groups respectively were 3.64 and 4.08. This was not a significant median difference according to the Wilcoxon rank sum test ($p=.403$). Kendall's tau was $-.11$ indicating no correlation between this variable and participation ($p=.506$).

Item 14 on the survey asked the homeowners whether they disagreed with the statement, "We especially enjoy the sunlight on the interior of our home." The mean scores for this item were 4.62 and 4.73 for the high and low groups respectively. There was not a significant median difference according to the Wilcoxon rank sum test ($p=.695$). Kendall's tau was .10 indicating no significant correlation between this variable and participation ($p=.445$).

3. DESIGN QUESTIONS

This section describes the research results relating to the design of the house. Participant responses regarding fading, television-viewing, open plan, and sunlight preferences are discussed. An analysis of the houses through studying floor plans and photographic slides revealed some dysfunctions in interior space planning which is discussed in the next section. Finally, selected examples of floor plans illustrate these problems in more detail.

Fading

Only six interview respondents indicated problems with fading or ultraviolet degradation of furnishings. However, fifty percent of the sample have lived in their houses one year or less. Some respondents have endeavored to minimize

this problem by appropriate actions. One respondent covers a chair with a coverlet during the winter. Another moves a grand piano seasonally to avoid deterioration of the wood finish. Still another switches end tables so that bleaching of the wood is even.

Television-Viewing

Sixty-five percent or seventeen respondents in the interview sample replied that they had problems with seeing a reflection of the southfacing window area when viewing the television set during the day. Most solved this problem by closing the draperies. However, other more energy-conserving measures were taken by some individuals. For instance, one homeowner hangs a pillowcase in only part of the window area to eliminate reflections. Another places a screen directly adjacent to the television which allows viewing while solar collection occurs. One homeowner moved the television to the master bedroom to alleviate the problem. Finally, a Virginia Beach solar homeowner discovered that vertical blinds eliminate veiling reflections by directing the light into the room while appearing to be closed to the television viewer.

Open Plan

In an answer to an open-ended question regarding their reaction to the open plan, seventy-seven percent or twenty of the interview sample replied that they enjoyed the feeling of spaciousness and openness of the open plan. Many cited this as the most positive feature of their house. However, six respondents or twenty-three percent indicated that the open plan caused acoustical conflict or privacy problems when several activities were going on. The combination of open plan and hardwood floors caused severe acoustical problems for one family with two young children.

Sunlight Preference

When asked an open-ended question about how they felt about the sunlight on the interior of the home, all responded positively with comments such as: "That's the best part." "I love it." The mean score for sunlight preference for the low design/build participation group was slightly higher (4.08) than for the high design/build participation group (3.64).

Interestingly, windows and sunlight were an important consideration when respondents answered a question regarding their favorite place in the house. Sixty-three percent answered that the reason why a particular place was

their favorite was because of the sunlight or view from the southfacing windows.

Indirect Gain Results

Only two participants in the sample had both direct and indirect gain systems. Both homeowners had a vented Trombe wall system, one in the bedroom and the other in a family room. The homeowners had quit operating the vents and planned to cover them. Both cited the unattractiveness of the vents and the inconvenience of using them as reasons for their dissatisfaction with them.

Space Planning

Participants were asked whether they had difficulty in arranging furniture in any room of their house. Fifty-nine percent or sixteen of the interview respondents answered "yes" and all cited the living room as a particular problem. Floor plans were obtained on twenty-five of the interview participant houses for further analysis. Furniture arrangement was noted on each of these plans. Several factors were examined including room size, orientation of furniture, furniture arrangement, circulation, zones, and passive elements. According to Table IV-12, room size itself does not appear to be a factor in homeowner dissatisfaction with furniture arrangement. In

Table IV-12

Mean Living Room Size* For the Design/Build
Participation Groups Based on Satisfaction
With Furniture Arrangement

	High Design/Build Participation	Low Design/Build Participation
Satisfied with Flexi- bility of Living Room Furniture Arrangement	307 n=4	187 n=5
Dissatisfied with Flex- ibility of Living Room Furniture Arrangement	233 n=7	227 n=7

*measured in square feet.

fact, the low design/build homeowners who were dissatisfied had an average living room size larger than the satisfied group. The factors that appeared to be important in the homeowner's dissatisfaction with the flexibility of arranging furniture in the living room were: 1.) zones, 2.) circulation, 3.) furniture arrangement, and 4.) passive elements. A discussion of these follow:

Zones

Zones or distances between different activity areas may have an influence on whether homeowners are dissatisfied. The concept of zones has its roots in ethology and anthropology research. Researchers of animal behavior have discovered that birds and mammals maintain uniform distances from members of their own species (Hediger, 1955). Hall (1969) has found that man too keeps uniform distances from his own kind. These he termed as intimate, personal, social, and public distances (p. 114). Each of these zones has a close and a far phase. The distance an individual uses, then, is dependent upon the social situation. For instance, the intimate zone (up to one and one-half feet) is used with loved ones while personal distance-close phase (one and a half to two and a half feet) is employed with loved ones and very close friends. The personal distance-far phase (two and a half to four feet) might be used also with close friends.

However, the social distance-close phase (four to seven feet) is seen in impersonal business situations and at casual social gatherings while the social distance-far phase (seven to twelve feet) is most often used on very formal business and social occasions. In the public zone (twelve to twenty-five feet or more), interaction between people is often restricted to loud speech and gesturing because of the long distances (p.125).

An understanding of these protective bubbles or proxemic zones is crucial. According to Hall:

The ability to recognize these various zones of involvement and the activities, relationships, and emotions associated with each has now become extremely important. The world's populations are crowding into cities, and builders and speculators are packing people into vertical filing boxes--both offices and dwellings. If one looks at human beings in the way that the early slave traders did, conceiving of their space requirements simply in terms of the limits of the body, one pays very little attention to the effects of crowding. If, however, one sees man surrounded by a series of invisible bubbles which have measurable dimensions, architecture can be seen in a new light. It is then possible to conceive that people can be cramped by the spaces in which they have to live and work. They may even find themselves forced into behavior, relationships, or emotional outlets that are overly stressful (p. 129).

Proxemic zones are significantly affected by furniture placement and sizes allotted to activity areas by the designer. An example is the typical layout of an executive office. The desk is often 36 inches deep while placement

of the guest chairs in front of the desk creates a proxemic zone of at least seven feet from the executive to the conferees or equivalent to the social distance-far phase often used in formal business occasions according to Hall (p. 125). This may partially explain the resistance the designer sometimes encounters with open-office systems where the proxemic distances created are frequently in the range of four to five feet or that of the social distance-close phase. This distance might be appropriate with co-workers but perhaps unwarranted in the more formal situation of office visitors.

In a residential setting, the proxemic zones are governed by sizes of activity areas and the configuration of those areas by the designer with door placement and by the occupant with furniture arrangement. Activity areas within the home can be classified on a private-social-public continuum. For instance, bedrooms are usually considered to be private areas while living and dining areas are more social. At the opposite end of the continuum is the public area which is typically the entry or where the family members meet outsiders. Thus, the distance from the entry to the living area is vitally important in whether the occupants feel comfortable in visitor situations. A distance of twelve feet or more yields a public zone. Depending on the nature of the

situation, the visitors may be invited to enter the more social zones of the living area. Hence, an entry-to-living zone of less than twelve feet essentially produces a social zone. This zone, then, can elicit a more informal interaction between occupants and visitors than is appropriate for the situation such as in the case of door-to-door solicitors. The resulting situation may be uncomfortable for both visitor and family members.

The entry-to-living zones were analyzed in this study because of the importance of this transition from public to social zones. Distances from the point of entry or the front door to a point where a person is considered to be in the living room were measured on the floor plans. The means were calculated and a contingency table was constructed to see if there were any differences in entry-to-living zones between the two participant groups based on whether they were satisfied or dissatisfied with the flexibility of living room furniture arrangement. Table IV-13 shows the results of this spatial analysis. Both satisfied groups had distances larger than 12 feet while the dissatisfied groups had less than 12 feet. The low design/build group that was dissatisfied had the lowest entry-to-living average distance or 6.5 feet. The t test was performed on the differences between the means of the high group as well as the low group. These were not significant. However, these

Table IV-13

Entry to Living Room Mean Distances* for the
Design/Build Participation Groups Based on
Satisfaction With Furniture Arrangement

	High Design/Build Participation	Low Design/Build Participation
Satisfied with Flexi- bility of Living Room Furniture Arrangement**	13.8 n=5	14.4 n=4
Dissatisfied with Flex- ibility of Living Room Furniture Arrangement**	11.4 n=8	6.5 n=8

*measured in linear feet.

**item 11 on the interview schedule.

findings still may suggest a possibility that the entry-to-living zones contributed to homeowner dissatisfaction. The next section describes another factor that may have contributed to homeowner dissatisfaction with the living room.

Circulation

Well-planned circulation in the home can save time, energy, and space. Poorly planned circulation, on the other hand, can interfere with furniture arrangement and cause discomfort for the occupants. Normally, through circulation in the living room is not recommended. Nevertheless, the characteristic open plan of passive solar design often dictates that traffic to other rooms or outside be routed through the living room. This requirement, however, need not cause problems if the circulation is configured properly or routed around conversational groupings.

The configuration of living room circulation was examined in order to determine if this was a factor in homeowner dissatisfaction. The mean scores on satisfaction with the flexibility of arranging furniture in the living room or item 3a on the Housing Satisfaction Scale were calculated and a contingency table was constructed for both participation groups based on whether circulation was required to go through conversational groupings in the

living room. Table IV-14 lists the results of this analysis. The average score was higher for the high design/build participation group with no circulation through the conversational grouping than it was for the same group with circulation routed through conversational groupings or 4.55 and 3.5 respectively. Although the low participation groups had scores lower than the high group, there was a difference based on whether circulation was routed through a conversational grouping. Specifically, the scores were 4.33 for the low design/build group with no circulation through a grouping and 2.67 for the group with circulation through a conversational grouping. T-tests were also performed on the differences between the means but these were not significant.

An alternate way of examining the data appears in Table IV-15. In this analysis, two groups were established by examining the mean score on satisfaction with flexibility of arranging furniture in the living room or item 3a on the Housing Satisfaction Scale. Those scoring above the mean were placed in one group while those scoring below the mean were placed in a second group. Then, a frequency table of circulation through the conversational grouping by the two groups was constructed. In this analysis, only three houses with through circulation appear in the high satisfaction group while 15 houses with no through circula-

Table IV-14

Mean Scores on Satisfaction With Furniture Arrangement*
For the Participation Groups Based on Incidence of
Circulation Through Conversational Grouping

	High Design/Build Participation	Low Design/Build Participation
Circulation Through Conversational Grouping	3.50 n=2	2.67 n=6
No Circulation Through Conversational Grouping	4.55 n=11	4.33 n=6

*Item 3a on Housing Satisfaction Scale which was a rating on a scale of 1 to 6 of the homeowner's satisfaction with the flexibility of furniture arrangement in the living room.

Table IV-15

Frequency of Circulation Through Furniture Arrangement by
Mean Score on Satisfaction with Living Room
Furniture Arrangement*

	Circulation Through Furniture Arrangement	No Circula- tion Through Furniture Arrangement
Flexibility of Living Room Furniture Score Over Mean (3.96)	3	15
Flexibility of Living Room Furniture Score Over Mean (3.96)	5	2

*Item 3a on Housing Satisfaction Scale which was a rating on a scale of 1 to 6 of the homeowner's satisfaction with the flexibility of furniture arrangement in the living room.

tion appear in this higher satisfaction group. In contrast, six houses with through circulation are in the low housing satisfaction group while only two houses with no through circulation are in this group.

The results of the analysis of circulation may indicate that homeowners are more dissatisfied if circulation is routed through conversational groupings in the passive solar living room. In addition, the examples of the spatial analysis presented at the end of this chapter reveal how site orientation in the passive solar development can have a strong impact on circulation in the home.

As mentioned previously, circulation can have an impact on furniture arrangement. This factor was examined more closely in the following section.

Furniture Arrangement

Research has shown that a corner-to-corner furniture arrangement is preferred for casual conversing (Sommer, 1969, p. 62). Although Sommer's research dealt with college students in a lounge environment, the results may be applicable to the residential environment as well. In the living room, an L-shaped furniture arrangement of the sofa and chair is equivalent to a corner-to-corner arrangement in Sommer's study. Circulation might have an

impact on whether one can achieve an L-shaped furniture arrangement.

The frequency of L-shaped furniture arrangement was noted for each floor plan. The mean scores on item 3a on the Housing Satisfaction Score which indicated satisfaction with the flexibility of arranging furniture in the living room were calculated for the two design/build participation groups based on whether there was an L-shaped furniture arrangement in the living room. This analysis is presented in Table IV-16. The average score for the high design/build participation group with an L-shaped furniture arrangement was 4.63 while the same group's average mean when there was no L-shaped furniture arrangement was 4.00. Similarly, the mean score for the low design/build group with an L-shaped furniture arrangement was 4.25 while the same group's mean score when there was no L-shaped furniture arrangement was 3.13. Again, the t-tests did not reveal that these differences were statistically significant.

Up to now, the analysis of dissatisfaction with the living room has concentrated on the layout of the floor plan by the passive solar designer. In the following section, passive solar elements are examined for their role in the flexibility of living room furniture arrangement.

Table IV-16

Mean Scores on Satisfaction With Furniture Arrangement*
for the Participation Groups Based on
Incidence of L-Shaped Arrangement

	High Design/Build Participation	Low Design/Build Participation
L-Shaped Furniture Arrangement	4.63 n=8	4.25 n=4
No L-Shaped Furniture Arrangement	4.00 n=5	3.13 n=8

*Item 3a on the Housing Satisfaction Scale which was a rating on a scale of 1 to 6 of the homeowner's satisfaction with the flexibility of furniture arrangement in the living room.

Passive Elements

Features common to passive solar design and direct gain designs in particular include south-facing windows, thermal storage areas, open plan, and auxiliary wood-burning units such as fireplaces and woodstoves. These passive features can affect placement of furniture and reduce the amount of available space for arranging furniture. For instance, full-length windows on the south wall often necessitate that only lightweight furniture be placed there so that the ultraviolet degradation is kept to a minimum and that solar collection is not impeded. The free clearances required by a woodstove can also greatly reduce the available living room space. In addition, thermal storage areas that are not integrated into the living room design can also take up needed space. Further, they can affect circulation and consequently impede furniture arrangement if poorly designed. Finally, open plan can be a factor in furniture arrangement because fewer interior walls are used. Consequently, only certain types and styles of furniture can be placed in the middle of a room (i.e. sofas and furniture pieces with finished backs).

The examples of spatial analysis examine in more detail the role of passive elements as well as zones, circulation, and furniture arrangement in inhibiting space planning and contributing to homeowner dissatisfaction.

Selected Examples of Spatial Analysis

This section presents examples of the floor plans where space planning was inhibited in the living room by the housing design. Both the high and low design/build participation groups are represented. Several of the low design/build participation homeowners were located in a large solar development in Richmond, Virginia. A detailed analysis of some of these houses reveals how the factors of entry-to-living zones, circulation, furniture arrangement, and passive elements can combine with site orientation to create problems for interior space planning.

Figure IV-1 is the first floor plan of a two-bedroom house design that has been built many times in this development. This version shows the staircase in the middle of the open plan. The living room has very limited possibilities for placement of furniture. Upholstery fabrics would rapidly deteriorate along the south wall window area. Consequently, the homeowners have placed lightweight wood chairs along the south-facing aperture. The location of the front door insures that some circulation will go through the conversational grouping. Moreover, an L-shaped furniture arrangement would be difficult to achieve.

Figure IV-2 shows the same plan with additions that the homeowner made. These additions were added, in part, to alleviate the problems encountered with space planning.

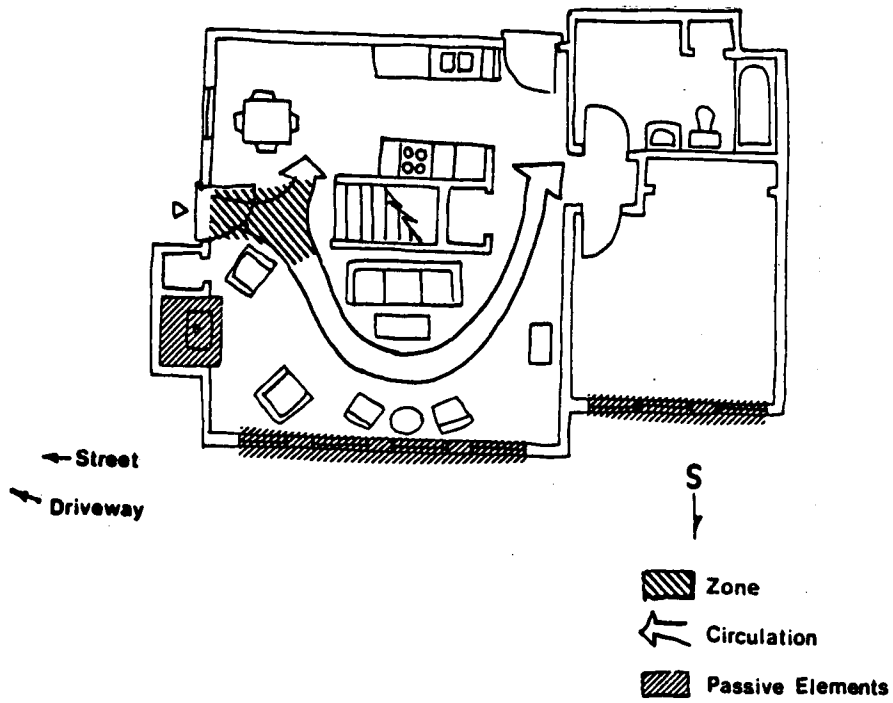


Figure IV-1
Spec-Built House Plan Illustrating
Circulation Dysfunction

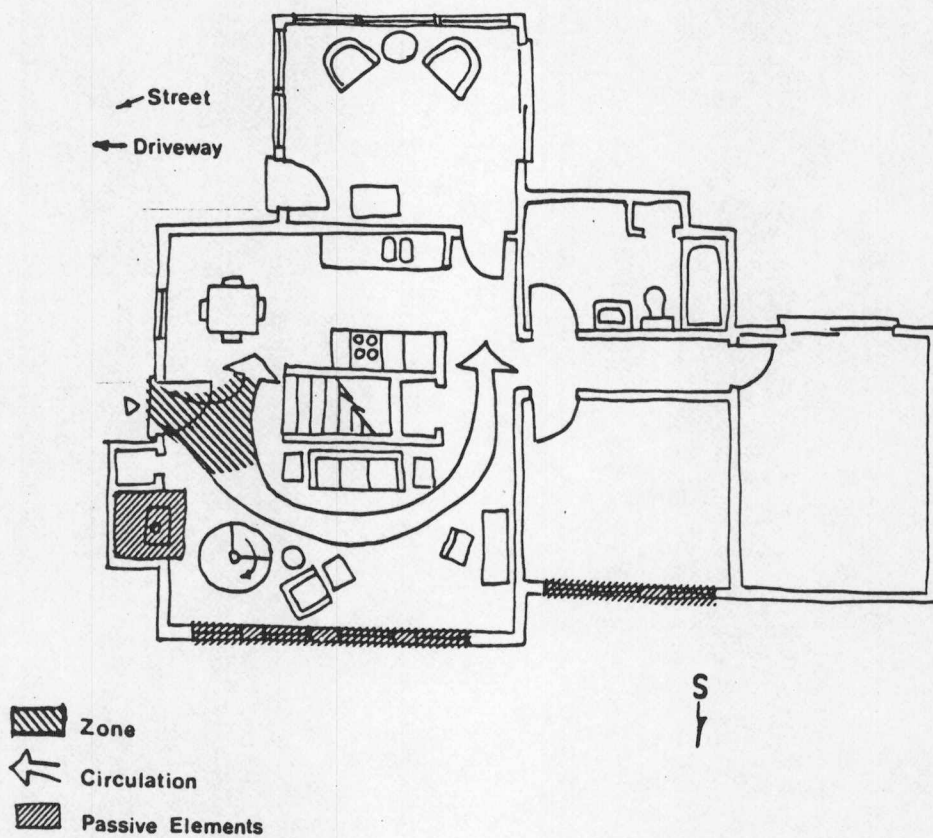


Figure IV-2

Spec-Built House Plan Illustrating
Owner-Built Additions

The original plan was identical to Figure IV-1 except that it also had a porch on the north side. The living room has a cathedral ceiling with skylights and an open loft above half the room. This homeowner disliked the staircase location; consequently, he installed a spiral staircase which adds more circulation area to the living room. The homeowners then glassed-in the porch on the north side and now use that year-round for the living room. They also added a master bedroom addition with a private deck and hot tub. These behavioral modifications greatly increased their electric bill. Their energy conservation index which indicates the number of BTU's consumed for auxiliary heating was 8873 while the average for the low design/build participation homeowners was only 4784. The homeowners had the lowest overall satisfaction (4 on a scale of 1 to 10) of all the participants in the study. Their dissatisfaction may have led them to make modifications which, although more compatible to their lifestyle, were detrimental to the energy performance and solar savings of the passive solar design.

Figure IV-3 is another version of the same house design. These homeowners were able to modify the plan before it was built. They chose to put an open staircase to one side of the living room and had the kitchen visually open to the living area. This increased the apparent size

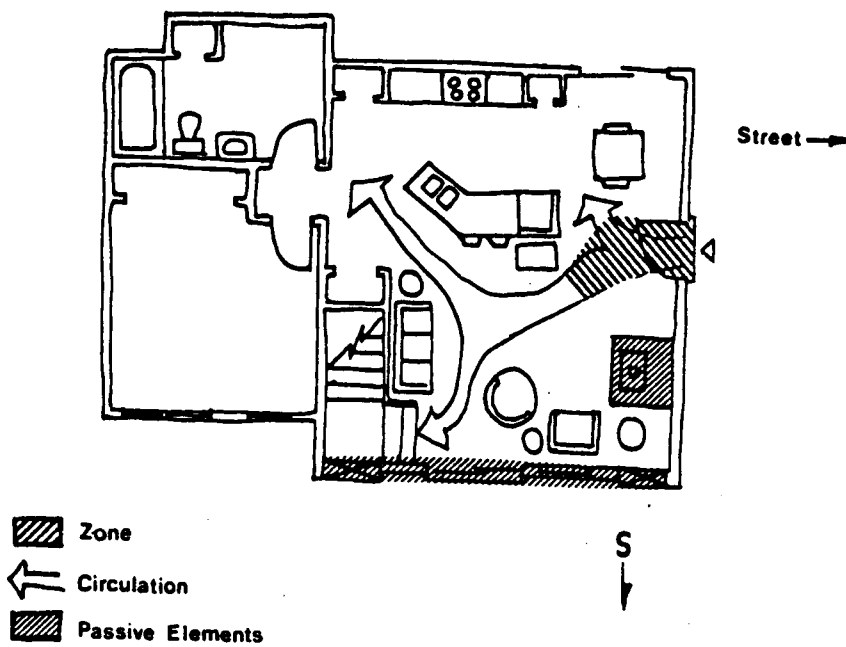


Figure IV-3

Plan Illustrating Owner Revisions to
Spec-Built House Design

of the room. Yet, their choice for front door location created problems for furniture arrangement in the living room. Because this problem was not unique to these subdivision homeowners, some elaboration is needed. As in most solar developments, the houses are situated on the lots in this subdivision to take advantage of the winter sun so that major glass area faces the south. Because the streets are curving in various directions in this development, the houses are situated in various orientations. Thus, the front door locations vary and are not always oriented directly to the street. In this instance, the developers wanted to put the front door in the kitchen area but the homeowners asked that it be put in the living room because they wanted it to be oriented to the street. This location ensured an awkward circulation pattern which goes through the conversational groupings. The sliding glass door to the deck and woodstove also inhibited the furniture arrangement in the living room. In this room, the only logical location for the television was on the north side which created veiling reflections of the south wall. The homeowners stated that they closed the window blinds when this occurred regardless of the time of year.

Figure IV-4 is the same plan as Figure IV-3 except that the kitchen counter is shaped differently and the

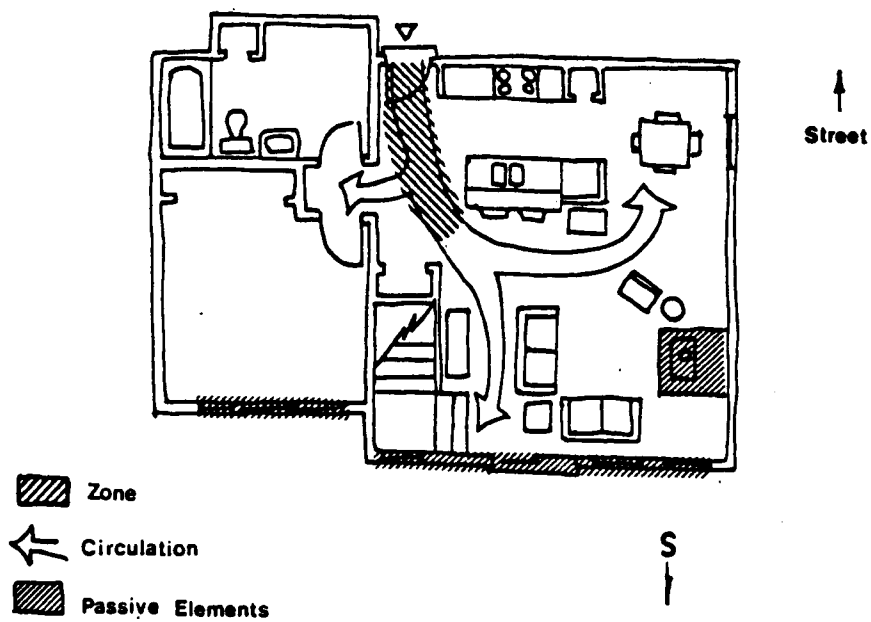


Figure IV-4

Spec-Built House Plan with Revised Stairwell
and Street in North Location

door is located as planned in the kitchen area. As the front door is oriented to the street, the homeowners were satisfied with its location. The homeowners were able to create one large conversational grouping around the woodstove. Although this was an improvement on the previous plan, the homeowners still were dissatisfied with the flexibility of the furniture arrangement. To get an L-shaped arrangement, there is only one way to achieve it. Further, the clearances required by the freestanding woodstove restricts the area for furniture.

Figure IV-5 illustrates a house plan with the same problem of the front door location. The back door was originally to be located in one of the bedrooms but the homeowners asked that it be located in the living room. Since the front door on the south side is not facing the street and is inconvenient to use, the homeowners use the back or side door as the front entry. But, the original front door location and entry closet creates excessive circulation and restricts the size of the living area. In fact, this homeowner complained about not being able to use all of her living room furniture. The entry-to-living zone is small and probably was the reason the homeowners placed the chair with its back to the door thereby providing a little more separation between entry and living area.

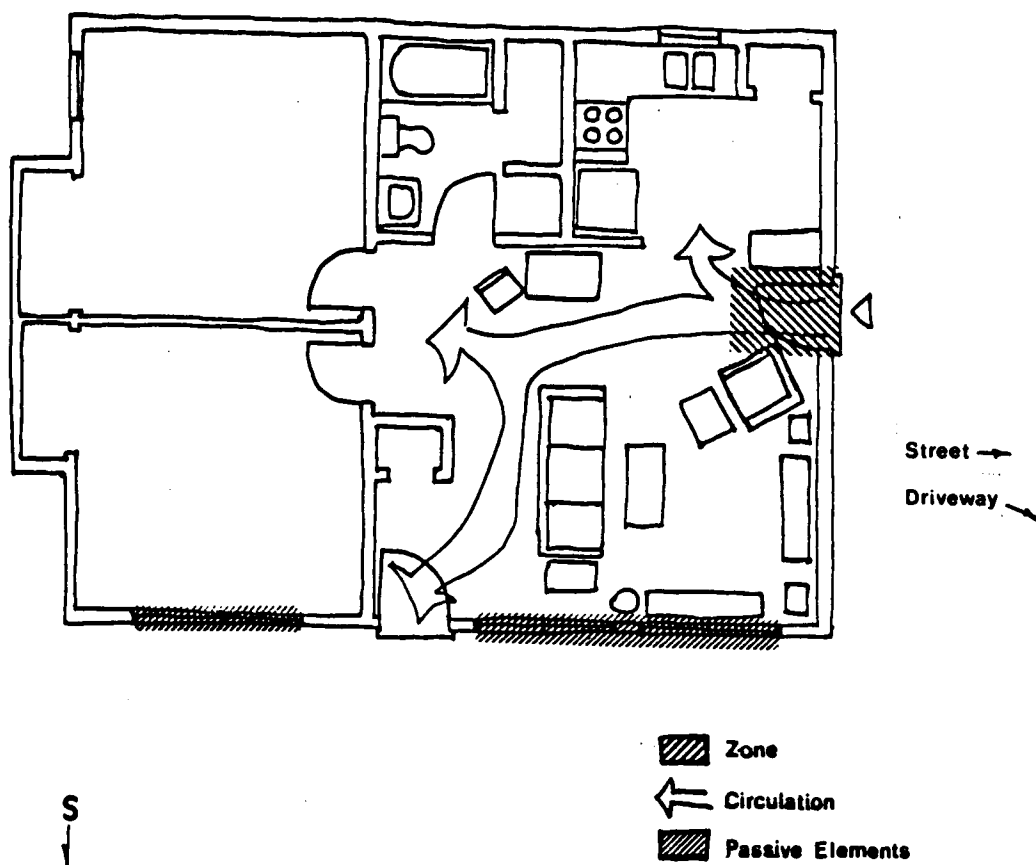


Figure IV-5

Plan Illustrating Front Door Dysfunction

The previous case studies were all low design/build participation homeowners. But problems with space planning were not limited to this group. The homeowners whose house plan is illustrated in Figure IV-6 also experienced dissatisfaction with furniture arrangement in the living area even though they designed and built their home. As a consequence, the homeowners are planning an addition to expand the living room to the west. An analysis of the plan reveals that passive elements contribute to problems with furniture arrangement. The glass area along the south wall, the open plan between dining and living, and the fireplace leaves only one clear wall to place furniture against.

Passive elements also are a major reason why furniture arrangement is restricted in the floor plans in Figure IV-7 and Figure IV-8. Thermal storage walls of brick are placed at a 45 degree angle in the dining and living area in the floor plan illustrated in Figure IV-7. These walls along with the woodstove restrict the size of the rooms leaving less space for furniture. Thermal storage area also contributes to restricting the size of the living room in the house plan in Figure IV-8. Rock storage consisting of fieldstone is located two feet from the south wall. The woodstove is placed on a platform inside the storage area. This design as well as the front door location makes it

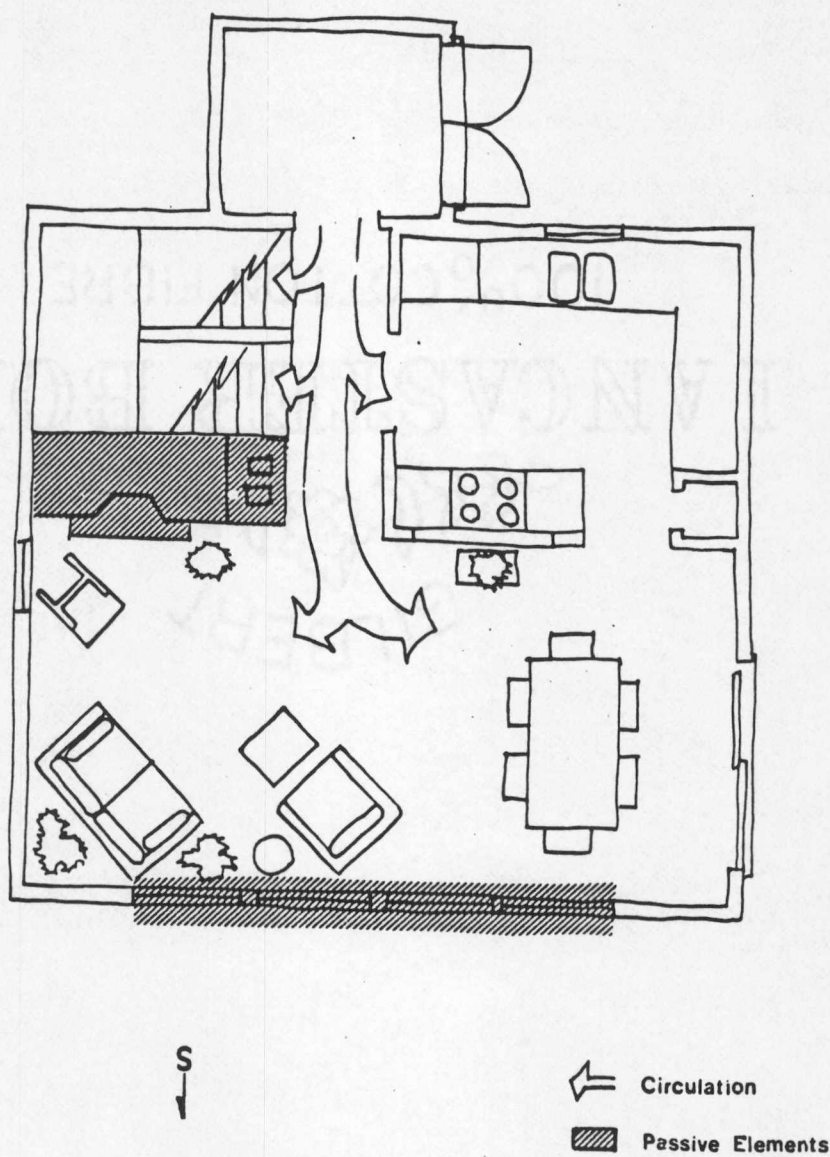
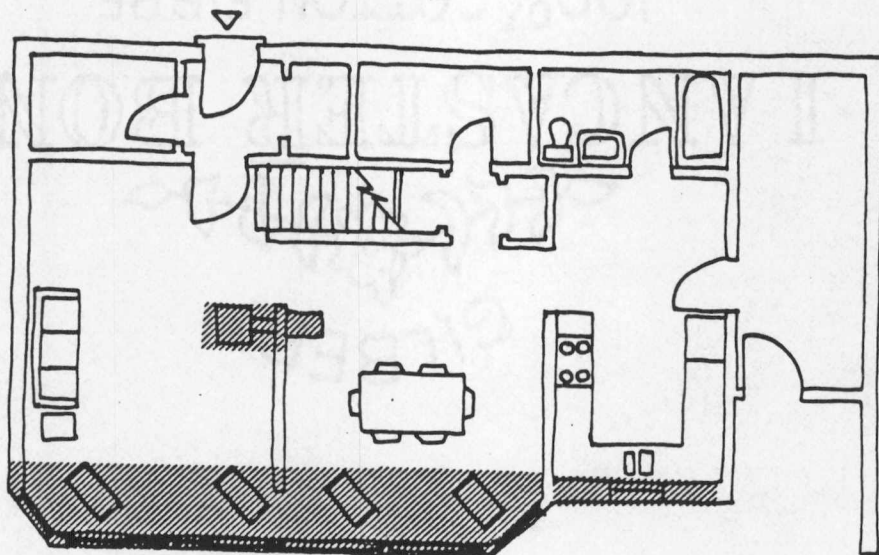


Figure IV-6

Owner-Built House Plan Illustrating Reduction
of Living Room Space by Passive Elements



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■ Passive Elements

Figure IV-7

Owner-Built House Plan Illustrating Passive
Elements Reducing Space for Furniture

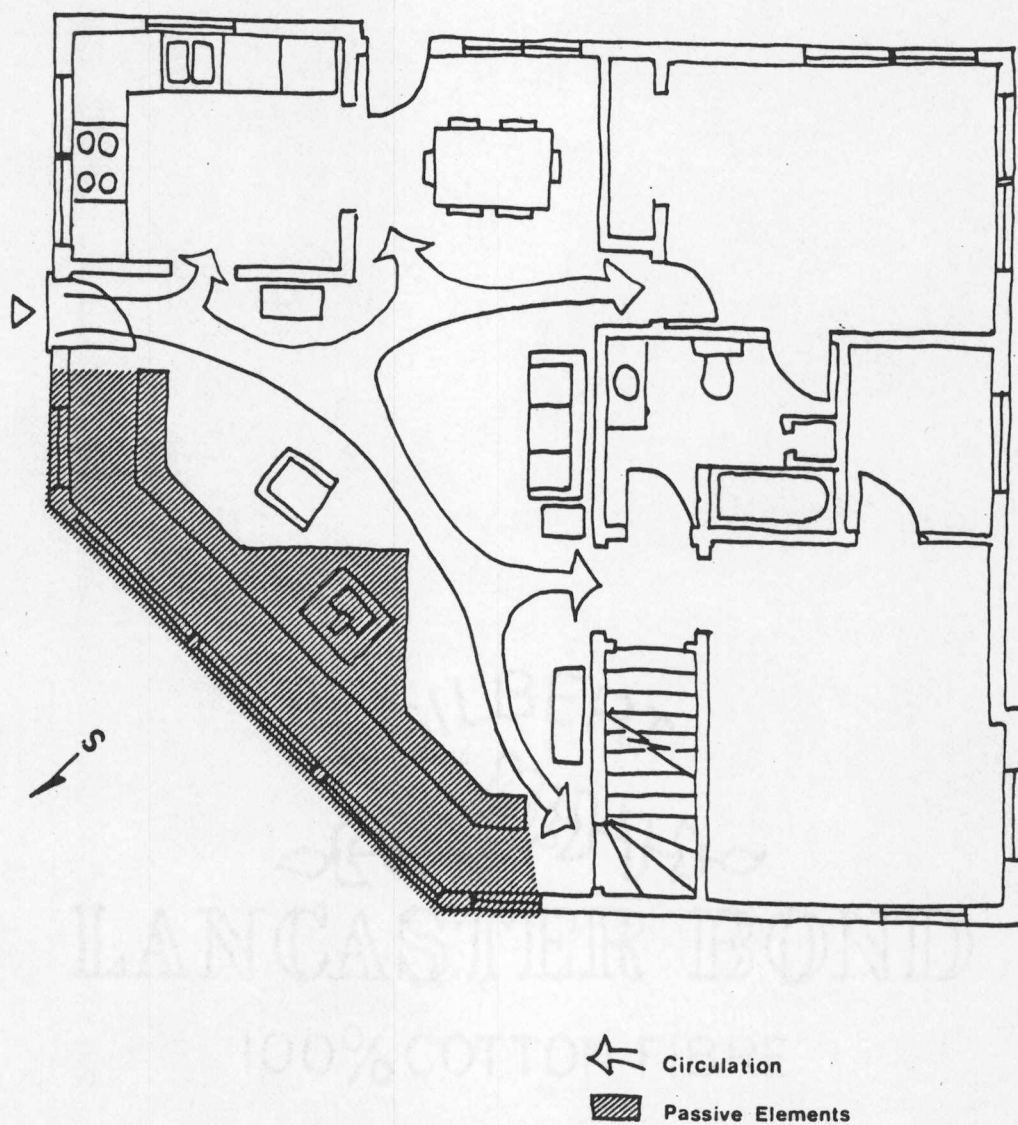


Figure IV-8

Owner-Built Plan with Passive Elements Disrupting
Circulation and Furniture Arrangement

difficult to achieve a furniture arrangement without having circulation go through conversational groupings. Although the living area is large (455 square feet), the combination of excessive circulation through the living area and the passive elements contributes to restricted furniture arrangement.

CHAPTER V

CONCLUSIONS AND RECOMMENDATIONS

A discussion of the results, conclusions, and implications of the research is presented in this final chapter. This examination would not be complete without the context of the theories and conceptual model that formed the framework of this dissertation. In this conclusion then, an attempt will be made first to integrate the findings with the theoretical rationale of the thesis. At the same time, areas will be pinpointed where the results signal a limitation of the methodology. The next section discusses the implications of this study for researchers and designers and makes some specific recommendations for optimizing passive solar design with user needs. Finally, recommendations are made for further study.

1. SUMMARY AND CONCLUSIONS

A field study of Virginia passive solar homeowners was conducted in 1984 in order to compare two groups of early adopters, those with higher and lower levels of participation in the design and/or building process. Most of the houses in this study were of the direct gain type or where sunlight is stored in the interior. The homeowners were surveyed and interviewed in their home. Floor plans and photographs were analyzed in addition to the

statistical analysis of the survey, observation, and interview data.

The purpose of this study was to compare the two groups of early adopters in order to establish whether there were any differences in characteristics, lifestyle, and needs. More importantly, a crucial objective was to assess the compatibility of the passive solar design with user needs. These initial objectives were guided by the conceptual model presented earlier which, in turn, was generated from the related research and theories.

A major prediction of the model was that the high design/build participation would have a higher level of satisfaction with their home than the low design/build participation homeowners. Satisfaction, though, represents a final stage of a process for the homeowners which is affected initially by the critical factor of participation in the design and building process. This user participation, first, affects the perceived attributes of passive solar. As innovation-adoption theory maintains, these attributes have consequences for adoption and, ultimately, satisfaction of the homeowners. The model predicted that higher participation should increase the perceived relative advantage, compatibility, and decrease the perceived complexity of the passive solar house. These factors would subsequently interact to affect the manner in which the

homeowners would deal with problems. For instance, increased compatibility and understanding of the passive solar system should enable the owner-builders to optimize their interaction with their home. Finally, this interaction would insure more energy savings and higher thermal comfort so that the owner-builders would have a higher level of satisfaction with their home.

Another important concept to this thesis was that the two groups of homeowners might differ in characteristics, values, and lifestyle. The rationale for this came from innovation-adoption theory and post-occupancy evaluations of solar homeowners. In general, people who adopt earlier in the adoption sequence have different characteristics, namely greater wealth and higher education, than people who adopt later. In addition to being wealthier and more educated, research has found that the solar adopters also have different values and lifestyle than the general population. These values included a stronger desire to conserve energy and use renewable resources or higher postmaterialist values while the lifestyle they maintained was one of voluntary simplicity. Innovation-adoption theory also has shown that early adopters are more innovative and more apt to be opinion leaders.

This overview of the guiding theories provides a framework for the following discussion of the results:

Characteristics, Values, and Lifestyle

The findings indicated that the high design/build participation homeowners were older, had a higher level of education, and had more persons in their household than the low design/build participation group of homeowners. The results regarding income showed no significant difference between the two groups although income rose for the high group when the very high participaters were dropped out of the statistical analysis.

The results regarding values were not conclusive. The high design/build group had lower economic or materialist values; yet, this might be partially explained by the higher income of the high participation group. The more income, the less these homeowners would have to worry about saving money. The results showed no differences between the two groups on measures of postmaterialist values of self-sufficiency or desire to use renewable resources. In the case of self-sufficiency, the measure may have been too ambiguous. Self-sufficiency can mean different things to individuals. In fact, this was the only item that several homeowners questioned as to its meaning. The low participation group may consider self-sufficiency as simply having enough income so that a person is not dependent upon others while the high participation group may view it in

terms of increased independence from utility companies as well as energy independence.

The conceptual model's prediction that the high group would have more optimal interaction with their passive system was supported by the finding that this group considered themselves to be more consistent and were more involved in performing maintenance tasks than the low participation homeowners. Yet, the homes in this latter group were characterized by fewer passive features; and, thus, fewer maintenance tasks were required of the homeowners. Consequently, the finding that the high design/build group were more involved with maintenance tasks is what might be expected because of the nature of the design of the houses.

The results regarding voluntary simplicity lifestyle were mixed. Although the correlation test revealed a low to moderate correlation between voluntary simplicity lifestyle and design/build participation, the Wilcoxon rank sum test using the same measure was not significant. A look at individual items on the voluntary simplicity index may explain why this occurred. The low participation homeowners were engaged in more physical exercise but less recycling than the high participation group. The increased amount of physical exercise may be partially explained by

the fact that the low group were younger and perhaps more inclined to exercise.

The study showed that the high participation homeowners had taken more energy conserving actions and had used less fuel for auxiliary heating. However, the amount of energy used for auxiliary heating is more dependent upon the design and quality of construction. Building an energy-efficient house requires strict attention to detail in the installation of insulation and weatherstripping. The spec-built homes may not have been as weather-tight or as insulated as the owner-built houses due to construction practices. Consequently, the energy conservation index may not fully reflect the energy practices of the homeowners.

The research showed that there were no differences in innovativeness for the two groups. In this case, the measure may not have been adequate. The measure was adapted from Farhar-Pilgrim and Unseld's (1982) research and simply asked for the number of innovative items the household had. Items such as microwave ovens, video games, and home computers may have been considered innovative to own in 1981 when their research was conducted. However, these items may be owned by a large number of households today.

The results did indicate that the high design/build homeowners had a higher number of opinion leadership activities as predicted.

These results regarding characteristics, values, and lifestyle cannot lead one to the conclusion that the spec-built homeowner represents a later adopter. The reason is clear: the differences can be explained simply due to the fact that the spec-built homeowners were younger or at an earlier stage in the family lifecycle. Thus, they may simply be the same population differentiated only by age. Because they were older, the high participation homeowners would probably have had more of an opportunity for graduate work, hence the finding that the owner builder had more education. And because they were older and with a higher level of education, the high group might be more likely to be opinion leaders. The age difference could also explain the differences in lifestyle as evidenced by the discrepancies on individual items on the voluntary simplicity index.

Satisfaction

As predicted by the conceptual model, the high participation had an overall higher level of satisfaction with their homes than the spec-built homeowners. Clearly, participation in the design and building process served to increase their satisfaction. Yet, homeowner satisfaction

is a complex process that was not explained fully by the model. The model predicted that increased perceived relative advantage and compatibility as well as decreased perceived complexity would interact to affect the homeowners' behavioral adaptation. This adaptation, in turn, would affect energy savings and thermal comfort which ultimately would serve to increase or decrease housing satisfaction. However, the statistical results failed to reveal these relationships. On the measures of perceived compatibility, the tests revealed no difference in magnitude.

Although the positive relationship between participation in the design and building process and housing satisfaction was not difficult to demonstrate, explaining that relationship is more of an arduous task. It is clear that the relationship is a complex one. The perceived attributes or variables such as increased compatibility and relative advantage may be difficult to measure. Certainly, the possibility exists that the measures on these variables in this study were inadequate or that the sample was of insufficient size to detect differences. Nevertheless, other factors besides perceived attributes may help explain the relationship between design/build participation and housing satisfaction.

One important factor to consider is cognitive dissonance. In a review and analysis of fifteen studies of owners of residential solar energy systems, Unseld and Crews (1979) concluded that cognitive dissonance theory may apply to the high satisfaction levels of these homeowners:

The theory of cognitive dissonance suggests that, when individuals simultaneously hold two cognitions (e.g., attitudes, perceived behaviors) that are psychologically inconsistent, they experience dissonance and will attempt to reduce this dissonance by changing one of the cognitions. Thus, for example, if a solar owner knows that s/he has invested a large sum of money or time in his or her system and also knows that the system is problematic, s/he might attempt to reduce the dissonance by ignoring the problems or by convincing himself or herself that the system's problems are minimal, particularly since the other cognition (knowledge of investment) is more difficult to change (p.61).

As the next section describes, there were some problems with the design of the passive solar houses; yet, both groups reported high levels of satisfaction. However, since the owner-builders had made more design decisions as well as spent more time and effort during the design and building process, they would have made more of an investment. As a result, they would have had more of an incentive to assume that they had, indeed, made the correct decisions. Sawyer (1979), studying satisfaction among solar adopters, concluded that . . . "they would be biased toward optimistic appraisals that would confirm the wisdom of their decisions." Admitting they were less satisfied,

then, would mean that the high participation homeowners would also have to admit they had made mistakes during the design and building process and had made a poor investment of time. Thus, the owner-builders report a higher level of satisfaction than the low participation homeowners to reassure themselves that they had made the right choice in building a passive solar house.

Other findings that help to explain homeowner satisfaction are related to the design of the passive solar houses. These results are discussed in the next section.

Design

A central issue in this thesis has been the concept of compatibility of passive solar design with human needs. Achieving a meaningful or compatible relationship between the built form and user needs, values, and lifestyle may be, in essence, the key to future adoption. The interview and observation items regarding design were intended to detect areas where the passive solar system was incompatible with user needs. The results showed both areas of compatibility and incompatibility.

The results regarding sunlight and the open plan suggest that these passive solar features were compatible with the aesthetic and psychological needs of the homeowners. People enjoyed the higher level of sunlight on

the interior of the house. Likewise, they liked the visual spaciousness and aesthetic characteristics of the open plan. Thus, these psychological aspects seemed to be important factors in homeowner satisfaction.

This study revealed some incompatibility between one very important family activity and the passive solar design. That is, television-viewing was hampered in the majority of households by the direct gain system. Yet, this did not seem to be a major source of dissatisfaction. Rather, many homeowners solved the problem easily by closing draperies. Others used more energy-conserving measures.

One very significant source of dissatisfaction was in space planning. The majority of homeowners reported that they had difficulty in arranging furniture in the living room. The spatial analysis revealed that several factors were important in determining satisfaction. First, the smaller the entry-to-living distance or zone, the more the homeowners were dissatisfied. Significantly, twelve feet was the cut-off point where homeowners were satisfied. This distance is precisely the same distance where Hall's (1969) proxemic zones transform from being social to public. Circulation through conversational groupings also proved to be a contributing factor to homeowner dissatisfaction. Related to this, homeowners were more

satisfied if they could achieve an L-shaped furniture arrangement. In solar developments, site planning can augment the circulation and furniture arrangement problem. For instance, some of the homeowners who were able to modify a stock building plan would be careful to place the front door so that it faced the street. This would then disrupt the circulation pattern in the living room. Finally, passive elements also were found to contribute to restricted space planning in the living room.

2. IMPLICATIONS AND RECOMMENDATIONS

Two separate but equally important issues arise when discussing the implications of this research. First, it is necessary to examine the purely practical aspects. That is, does the study offer designers some very concrete suggestions on how to improve the passive solar design process? Secondly, how does the study help explain the state of the art of passive solar design today?

The first question is rather easily answered. This study has documented specific areas of incompatibility between the design and specific family needs. To this end, design recommendations will be made that can alleviate these problems.

To answer the second question, it is necessary to return to an initial assertion in this dissertation that

there is a strong rationale for the widespread adoption of passive solar design techniques; yet, disappointingly, adoption has remained in a very early stage. This research offers clues as to why this has occurred. Although the study reveals some strong compatibility between psychological needs and the passive solar design, there is, at the same time, one area of disturbing incongruence. That is, as it is practiced today, passive solar design has failed to provide very fundamental needs in terms of ensuring unencumbered space for family group-living activities. This finding is not as surprising as one might think if developments in solar technology in the past decade are examined more closely. The initial impetus for research in solar utilization prompted many to focus on the energy-savings aspects of the design. This focus on energy conservation lingers today. Yet, a new design strategy or goal is necessary in order to insure that passive solar design proceeds beyond the early adoption stage. In essence, the goal of passive solar design should be to provide a compatible relationship between the built form and human needs. This does not mean that energy savings have to be compromised. On the contrary, the wide selection of energy-conserving building technologies available enable the designer to devise schemes which can be compatible with human needs. In fact, energy savings

may be increased because behavioral interaction with the home would be optimized. For example, a passive solar living room that is compatible with the sunlight preferences of the homeowner, that does not interfere with television-viewing, and that provides flexibility in furniture arrangement will keep occupants from closing draperies during solar collection hours. Thus, solar savings can be maximized.

Another implication of this research is in reference to user participation in the design and building process. This study has established that participation in design and building increases homeowner satisfaction. Thus, an important question arises as to whether it is possible to increase user participation in the housing process. Since approximately 60% of single-family homes are built on speculation on the builder's land in this country (Lindamood and Hanna, 1979, p.339), any increase in participation by potential buyers would serve to increase substantially housing satisfaction. The research offers insight into how this participation might be enhanced in the spec-built housing process. Several instances were documented in one solar development where homebuyers were able to modify stock building plans. Still, it is not clear whether these homeowners understood the consequences of these modifications on space planning simply by examining

floor plans. One possible solution is for the builders to use scale models to work with potential buyers. Not only are scale models more comprehensible, they can be modified easily. At the same time, the designer can show other possible solutions to the buyer while also communicating the effect of any proposed change on building costs and energy savings.

Increased user participation in the design and building process can be attained also by offering the homebuyer more choices. This can be achieved by having more variations on stock building plans. This seems mandatory when the site plans are highly variable. The next section details generic design guidelines that should be helpful in accomplishing this objective.

Design Recommendations

The examples of spatial analysis presented in Chapter IV illustrated how site planning could combine with passive solar design to create problems in space planning. The problem was especially acute for smaller size houses. The following general guidelines were devised for smaller size housing (approximately 900 square feet of living space) in order to give designers specific configurations of the living area for each site orientation. Obviously, these guidelines were not intended to represent final plans.

Nevertheless, they are most useful to designers as conceptual aids during the design process. Trained as visual thinkers, designers can respond better to graphic symbols of behavioral information than to written lists of requirements (Laseau, 1975).

Each scheme provides: 1. L-shaped conversational grouping, woodstove with adequate clearance, and television in the living area, 2.) front door facing the street with service entrance on driveway side, and 3.) an entry-to-living zone of at least 12 feet. Each diagram could be used in reverse. For example, Figures V-1 and V-2 would need to be built in reverse if the driveways were on the opposite side. In addition, the reverse of the scheme presented in Figure V-3 would be used for a site where the street is on the east side. Figure V-2 also takes into consideration the privacy issue where the front door is facing the south side. Consequently, two full-height and two partial height mass walls are used.

3. RECOMMENDATIONS FOR FURTHER RESEARCH

As with all research, the conclusion of a study offers an opportunity to explore avenues of improvement. This research could have been improved, first, by increasing the sample size. A larger sample would make the statistical

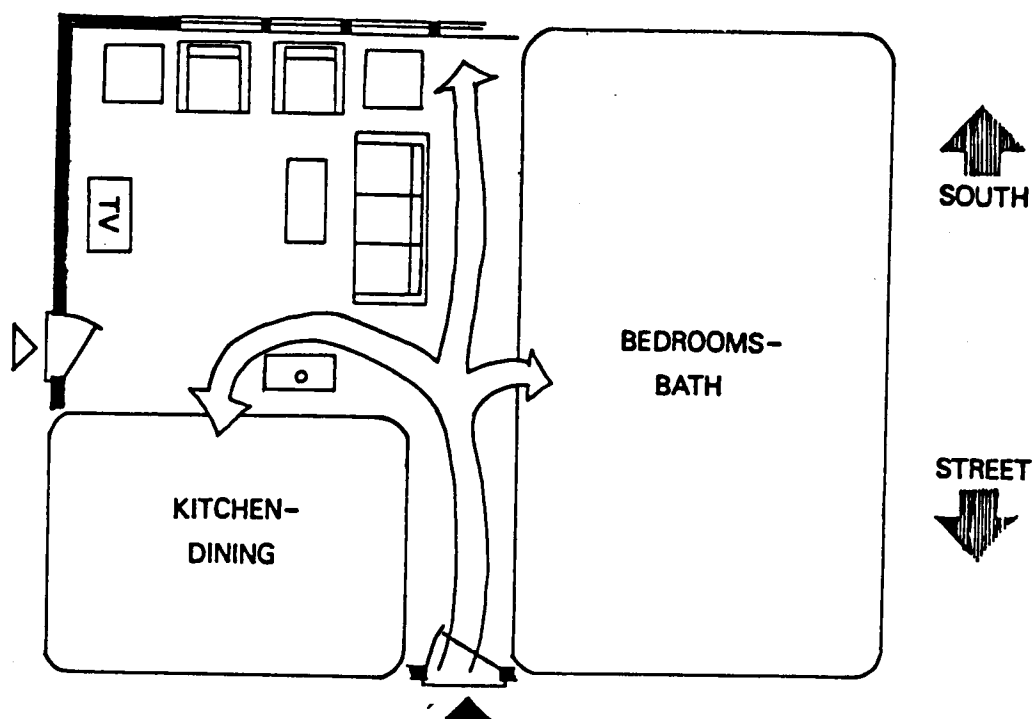


Figure V-1

Design Guideline for Passive Solar House
for Street in North Location

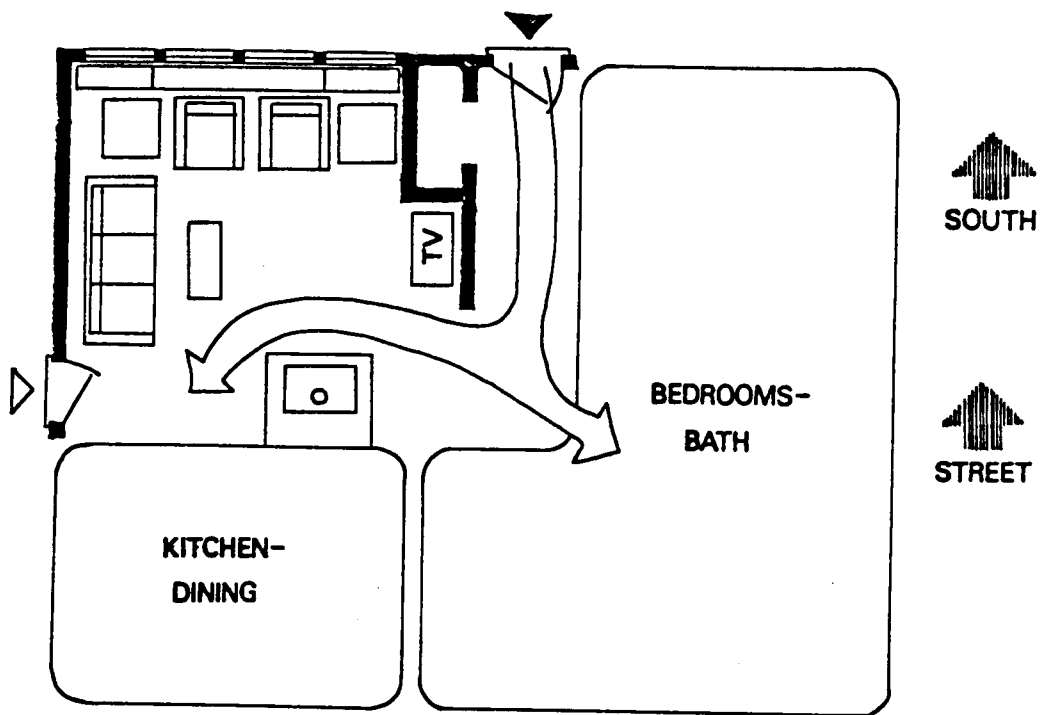


Figure V-2
Design Guideline for Passive Solar House
for Street in South Location

Nevertheless, they are most useful to designers as conceptual aids during the design process. Trained as visual thinkers, designers can respond better to graphic symbols of behavioral information than to written lists of requirements (Laseau, 1975).

Each scheme provides: 1. L-shaped conversational grouping, woodstove with adequate clearance, and television in the living area, 2.) front door facing the street with service entrance on driveway side, and 3.) an entry-to-living zone of at least 12 feet. Each diagram could be used in reverse. For example, Figures V-1 and V-2 would need to be built in reverse if the driveways were on the opposite side. In addition, the reverse of the scheme presented in Figure V-3 would be used for a site where the street is on the east side. Figure V-2 also takes into consideration the privacy issue where the front door is facing the south side. Consequently, two full-height and two partial height mass walls are used.

3. RECOMMENDATIONS FOR FURTHER RESEARCH

As with all research, the conclusion of a study offers an opportunity to explore avenues of improvement. This research could have been improved, first, by increasing the sample size. A larger sample would make the statistical

analysis more discriminating of differences between the two groups.

In a similar manner, differences might also be better discerned by having more detailed measures on values and lifestyle. For instance, the innovativeness measure might be improved first by finding out what exactly constitutes innovative behaviors, i.e. reading specific magazines or books, attending certain activities, or by buying innovative technology. Then a checklist could be made similar to the opinion leadership list in this study. The voluntary simplicity index also could be improved by having more questions regarding activities. Deemphasizing physical exercise as a voluntary simplicity behavior may be helpful too. The motive for engaging in physical exercise seems to be as much associated with increasing one's physical attractiveness as it is with voluntary simplicity.

The measure on design/build participation could have been improved by adding more levels. Conceptually, there is a large leap from selecting interior finishes to working with a designer on developing a solar house plan. Several homeowners were able to modify a stock building plan by moving windows, doors, or other structural features. Yet, they were placed in the low design/build participation group. One or two levels should be added between level one

and two which reflect this increased participation in the design process.

The part of the study which deals with demographics, values, lifestyle, house characteristics, and many of the measures on satisfaction could easily be accomplished by survey methods which are less expensive and time-consuming than the field study. This, of course, would enable one to obtain a larger sample.

Having the homeowners complete a diary for one year would be advantageous in that one could obtain precise detail on daily activities such as operation of woodstove, use of rooms, and other family activities. Although the likelihood of homeowners participating in such a study may be remote without a reward, the accuracy and fine detail that could be generated would be very useful.

Further spatial analysis of passive solar housing is needed. Research of this type does not exist; yet, it yields very practical and cost-effective results. A large nationwide field study of solar housing would indicate whether the problems with space planning uncovered in this study were indigenous to Virginia or are characteristic of passive solar homes across the United States. A field study rather than simply a survey is necessary since floor plans would need to have the homeowner's furniture

arrangement noted on each plan. In addition, photographic slides would augment this analysis.

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LIST OF REFERENCES

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APPENDIXES

APPENDIX A
CORRESPONDENCE



COLLEGE OF HUMAN RESOURCES

VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY

Blacksburg, Virginia 24061

DEPARTMENT OF HOUSING, INTERIOR DESIGN AND RESOURCE MANAGEMENT (703) 961-6163

Dear Passive Solar Homeowner:

I am conducting a study of passive solar homes as a part of my dissertation research at The University of Tennessee. The information obtained in this study will be used in improving the design standards for passive solar housing.

I would like to ask you to participate in this study. Your participation would involve completing a questionnaire, talking to me in your home, and, if possible, allowing me to take photographs of your house.

If what I propose is acceptable to you, we can discuss later a time to meet. Thank you for your consideration of this request.

Sincerely,

Joan McLain-Kark
Assistant Professor
Interior Design



COLLEGE OF HUMAN RESOURCES

VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY

Blacksburg, Virginia 24061

DEPARTMENT OF HOUSING, INTERIOR DESIGN AND RESOURCE MANAGEMENT (703) 961-6163

September 28, 1984

I am conducting a study of passive solar homes in Virginia in order to give feedback to designers on homeowner reactions. I am hoping that you will participate by filling out the enclosed questionnaire. Although the questionnaire is several pages, it should only take a few minutes to complete. A stamped envelope is enclosed for your convenience.

Please feel free to make any comments about your home. Your comments as well as any other responses will be kept anonymous.

Your participation will be greatly appreciated.

Sincerely,

Joan McLain-Kark
Assistant Professor
Interior Design

JMK/jb

Enclosure

I consent to be interviewed in my home for the "Passive Solar Evaluation Study."

I understand that at any time during the course of this interview I may cease to participate if I so choose or refuse to answer any questions I so choose.

Signed _____

Date _____

I give the investigator permission to take pictures of my home.

I understand that these photographic slides of my home will be used for educational and research purposes and may be shown at professional meetings to report on the research.

Signed _____

Date _____

APPENDIX B
INTERVIEW INSTRUMENT

No. _____

INTERVIEW SCHEDULE (IS)

1. How many years have you lived in your house? _____
2. What year was your house built? _____
3. Please describe how your passive solar house works:
 - ___ a. roof overhang
 - ___ b. window area faces south
 - ___ c. earth sheltered on north side
 - ___ d. windbreak evergreen trees on north side
 - ___ e. mass wall collects heat room(s) _____
 ___ partial height full height _____
 ___ vented ___ unvented
 ___ water type: Drumwall ___ Kalwall tubes ___ One Design ___
 Other:
 ___ concrete type: block ___ poured ___
 ___ other (phase change, etc.): _____
 - ___ f. mass floor collects heat room(s) _____
 type: _____
 - ___ g. movable insulation insulates windows at night
 - ___ h. hybrid: describe _____

Other features: _____

What sources of information did you consult before buying or building your home?

magazines _____ (titles _____)
Books _____ (titles _____)
Nat'l Cooling & Heating Information Service _____
federal government publications _____
state government publications _____
extension publications _____
utility publications _____

4. System type:
 - Direct gain _____
 - Direct gain/indirect gain _____
 - Direct gain hybrid _____

5. Check one of the following statements which most accurately reflects the homeowner's involvement in the design and construction of the house.

- ☐ (0) No involvement.
☐ (1) Selected or helped select wall and/or floor finishes.
☐ (2) Worked with designer on floor plan and/or solar features.
☐ (3) Designed floor plan and/or solar features.
☐ (2) Contributed physical labor during construction.
☐ (3) Did most of the actual construction of the house.

Total: _____

6. Would you run me through a typical weekday's routine for your family:
(KIT, DR, BR, BA=bath, FR, BS=basement, etc.)

Order of occurrence	Room activity located	Time	Comments:
☐ a.m. wake up	_____	_____	
☐ use bath	_____	_____	
☐ dress	_____	_____	
☐ turn up thermostat	_____	_____	
☐ fire up woodstove	_____	_____	
☐ turn on space htr	_____	_____	
☐ fix breakfast	_____	_____	Who?
☐ eat breakfast	_____	_____	

All household members eat at same time? Yes _____ No _____

If not, indicate members and time for each:
(F=father, M=mother, D=daughter, S=son)

_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
☐ open draperies/shutters	_____	_____	
☐ go to work	_____	_____	Who?
☐ read	_____	_____	
☐ watch T.V.	_____	_____	
☐ yardwork	_____	_____	
☐ housework	_____	_____	
☐ return home	_____	_____	
☐ close shutters	_____	_____	
☐ turn on space htr	_____	_____	
_____	_____	_____	
_____	_____	_____	
_____	_____	_____	

Comments: _____

***Would you run me through a typical weekend day's routine:

Order of occurrence	Room activity located	Time	Comments:
___ a.m. wake up	___	___	
___ use bath	___	___	
___ dress	___	___	
___ turn up thermostat	___	___	
___ fire up woodstove	___	___	
___ turn on space htr	___	___	
___ fix breakfast	___	___	Who?
___ eat breakfast	___	___	
All household members eat at same time? Yes___ No___			
If not, indicate members and time for each:			
(F=father, M=mother, D=daughter, S=son)	___	Time	___
	___		___
	___		___
___ open draperies/shutters	___	___	
___ turn down thermostat	___	___	
___ go to work	___	___	Who?
___ read	___	___	
___ watch T.V.	___	___	
___ yardwork	___	___	
___ housework	___	___	
___ close shutters	___	___	
___ return home	___	___	
___	___	___	
___	___	___	
___	___	___	
___	___	___	

Comments: _____

How do you feel your family's daily routine differs now as compared to the daily routine in previous houses you've lived in?

___ extra task: woodstove

___ extra task: movable insulation

___ extra task: operate vents

___ activities occur in different rooms

___ sit and look outside more

___ family spends more time together

___ family spends more time at home

___ family member(s) spend more time working on house

___ other:

HOUSEHOLD MEMBERS, SEX, AND AGE

Sex	Age	Relationship
___	___	_____
___	___	_____
___	___	_____
___	___	_____
___	___	_____
___	___	_____

7a. Maintenance tasks for system and auxiliary heating:
(coded for intensity of involvement)

- ___ (0) No maintenance tasks.
- ___ (1) Opening/closing shutters (less than 5 mins. per day).
- ___ (2) Opening/closing shutters (about 10 mins. per day).
- ___ (3) Opening/closing shutters (over 10 mins. per day).
- ___ (1) Operating vents or fans (less than 5 minutes per day).
- ___ (2) Operating vents or fans (about 5 mins. per day).
- ___ (3) Operating vents or fans (over 10 mins. per day).
- ___ (1) Seasonally adjusting or applying shading devices.
- ___ (3) Operating woodstove.
- ___ (3) Making repairs or adjustments to system.

Total: _____

7b. On a scale of one to five, what would you say your level of enjoyment is with the solar maintenance tasks (excluding woodstove operation)? 1 2 3 4 5

7c. On a scale of one to five, what would you say your level of enjoyment is with the woodstove operation? NA_____ 1 2 3 4 5

I AM INTERESTED IN THE FURNISHINGS YOU CHOSE FOR YOUR HOUSE
(NOTE: ASK ONLY THOSE THAT ARE RELEVANT)

8. Window Treatments:

Type:	Mfgr or description	Room	Satisfaction				
pull down shade			1	2	3	4	5
pulley shade			1	2	3	4	5
draperies			1	2	3	4	5
pvc rolling shutter			1	2	3	4	5
horiz. 1" blind			1	2	3	4	5
vertical blind			1	2	3	4	5
roman sh.(wood)			1	2	3	4	5
roman sh.(fabric)			1	2	3	4	5

Comments _____

On a scale of 1 to 5, what would you say your level of enjoyment is with the operation of the window treatments? 1 2 3 4 5

Comments _____

9. Do you have any suggestions for designers of energy efficient window treatments or movable insulation?

- ☐ easier to use ☐ more insulating
☐ better-looking ☐ available in more colors
 other: _____

10. Floor covering (living area):

- a. ☐ quarry tile (color _____ reflectance _____ size _____)
 b. ☐ ceramic tile (color _____ reflectance _____ size _____)
 c. ☐ brick floor (color _____ reflectance _____)
 d. ☐ seamless vinyl covering (color _____ reflectance _____)
 e. ☐ hardwood (stain: _____ finish _____)
 f. ☐ pine or softwood (stain _____ finish _____)
 g. ☐ carpeting (color _____ reflectance _____ type _____)

11. Do you feel that furniture was difficult to arrange in this house in any room? What room? _____ Other rooms? _____

Very difficult to arrange _____

Somewhat difficult to arrange _____

Not difficult to arrange _____

If so, why? _____

12. Have you noticed any problems with fading of fabrics or deterioration of surface finishes? Yes _____ No _____

If yes, describe: _____

THERMAL COMFORT

(HYPOTHESIS 6 & 7)

13. What is the warmest area of the house in the winter? _____
time of day _____

Is there anything you particularly do about the warm areas? Yes__No__
If yes, what do you do?

CODED AS NUMBERED: 0=less effective interior design or clothing management to conserve energy. 3-5=more effective interior design or clothing management to conserve energy.

- ____ (2) Take off some clothing (to short sleeves).
- ____ (3) Take off most of clothing (i.e. shorts and t-shirt).
- ____ (2) Move to another area of house.
- ____ (0) Close draperies or shades.
- ____ (0) Open windows to vent heated air outside.
- ____ (1) Turn on fan to circulate air to other part of house.
- ____ (0) Turn on air conditioning.

Other actions _____

14. What area of the house gets the coolest during the winter? _____
Is there anything you particularly do about the cool areas? Yes__No__
If yes, what do you do?

CODED AS NUMBERED: 0=less effective interior design or clothing management to conserve energy. 1-3=more effective interior design or clothing management to conserve energy.

- ____ (1) Fire up woodstove/fireplace.
- ____ (2) Move closer to woodstove for warmth.
- ____ (0) Turn up auxiliary central heating.
- ____ (1) Turn on space heater (i.e. kerosene or electric).
- ____ (2) Put on a warm clothing item (i.e. a sweater).
- ____ (3) Put on two warm clothing items (i.e. sweater and hat).
- ____ (4) Put on three or more warm clothing items (sweater, vest, hat, insulated underwear, etc.).

Other actions _____

(HYPOTHESIS 6)

15a. Are there some areas of the house your family does not use in the wintertime? Yes_____ No_____ If yes, does the family sometimes close off the rooms from the heating? Yes_____No____
Yes=1

15b. Have you done any of the following things to conserve energy after the house was already built? (Each response coded as 1 and added with 13 and 14 for willingness to conserve energy index.)

- ___ a. added additional weatherstripping and insulation.
- ___ b. lowered water heater thermostat to below 110 degrees.
- ___ c. lowered thermostat of auxiliary central heating to below 65 degrees or keep indoor temperature with other auxiliary heating to below 65 degrees.

VISUAL COMFORT

(HYPOTHESES 6 & 7)

16. What measures have the homeowners taken to adapt to glare:

CODED AS NUMBERED: 0=less effective interior design or clothing management to conserve energy. 1+=more effective interior design or clothing management to conserve energy.

- ☐ (1) rearranged furniture to ☐ (0) seating facing south wall face away from window.
☐ (1) put on sunglasses. ☐ (0) close draperies
☐ (1) put in many houseplants ☐ (0) no evidence of efforts to diffuse the light. ☐ (0) diffuse light.

Based on observation, indicate severity of glare problem (Document with photographic slides):

- ☐ severe problem.
☐ moderate problem.
☐ minor problem.
☐ no problem.

17. In walking through your house, I noticed the sunlight coming through those windows. How do you feel about the sunlight?
(CODED: 0=lower sunlight preference, 1=higher sunlight preference)

First item mentioned:

- ☐ (1) The sunlight is great for raising plants.
☐ (1) I like the sunlight to sunbathe or just sit in the sun.
☐ (1) I really like the look of the sunlight in the room.
☐ (0) The sunlight sometimes bothers me so I close the shades.
☐ (0) I worry about the sunlight fading the furnishings.
☐ other:

18. Do you ever sit in the sun to read (in the house during the winter)?

- ☐ (0) Never ☐ (1) Sometimes ☐ (2) Often

19. Do you ever sunbathe in the wintertime in the house?

- ☐ (0) Never ☐ (1) Sometimes ☐ (2) Often

20. Do you sometimes just watch the sunlight in the room?

- ☐ (0) Never ☐ (1) Sometimes ☐ (2) Often

Total (Satisfaction with Sunlight) 17 thru 20:

21. Where does television viewing occur? _____
Do you have problems with too much light or veiling reflections?
Yes___ No___ If yes, what have you done about it?

22. What are the most positive aspects of your house?
- ☐ like the feeling of sunlight and warmth.
 - ☐ the energy savings.
 - ☐ the fact that we use a renewable energy resource.
 - ☐ the house design and layout fits our needs well.
 - ☐ location.
 - ☐ appearance.
 - ☐ innovative solar features.
 - ☐ site and yard.
 - ☐ neighborhood and neighbors.
 - ☐ ease of maintenance and convenience.
 - ☐ roominess and spaciousness.
 - ☐ low cost
 - ☐ other:
23. What are the most negative aspects?
- ☐ not as much energy savings as expected.
 - ☐ too much sun.
 - ☐ not enough sunlight.
 - ☐ overheating.
 - ☐ appearance.
 - ☐ house doesn't fit in neighborhood.
 - ☐ house too small.
 - ☐ lack of privacy.
 - ☐ neighborhood and neighbors.
 - ☐ location
 - ☐ house design and layout does not fit our needs.
 - ☐ amount of maintenance and inconvenience.
 - ☐ traffic
 - ☐ cost of home.
 - ☐ other:
24. If there is anything you could change about your house, what would it be?
- ☐ solar features simpler.
 - ☐ house larger.
 - ☐ look more conventional.
 - ☐ less costly.
 - ☐ location.
 - ☐ site and yard.
 - ☐ house design and layout.
 - ☐ maintenance.
 - ☐ neighborhood and neighbors.
 - ☐ appearance.
 - ☐ other:

25. Compared to previous homes you have owned or lived in, how is this house different?
- ☐ open plan or multi-purpose room.
 - ☐ more sunlight in house.
 - ☐ located in more secluded area.
 - ☐ cozy and warmer in winter.
 - ☐ cooler in summer.
 - ☐ other:
26. Open Plan: Yes ☐ No ☐
- I noticed that the living-dining-kitchen is open (no walls). Does this affect your family in anyway?
- ☐ acoustics can cause interference in activities.
 - ☐ able to communicate with others in different area.
 - ☐ able to supervise children better.
 - ☐ other:
- What do you like best about the open plan?
- ☐ spaciousness and feeling of openness.
 - ☐ uniqueness of design.
 - ☐ can supervise children better.
 - ☐ other:
- Is there anything you dislike about the open plan?
- ☐ acoustical conflicts when family members trying to do two different activities.
 - ☐ not enough wall space to hang pictures.
 - ☐ not enough walls to put furniture against.
 - ☐ not enough storage space.
 - ☐ other:
27. Where is your favorite place in the house? _____
- Why? _____
- The children's favorite place? _____
28. On a scale of 1-10 (10 being the highest), how would you rate your overall satisfaction with your home? _____

ENERGY CONSUMPTION

Location: _____ Heating Degree Days: _____
 Square Footage (include walk-out basement): _____

Type of auxiliary heating: Gas _____ Oil _____ Electric _____ Kerosene _____
 Other: _____

	UTILITY BILLS							
	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	Total
Electric	_____	_____	_____	_____	_____	_____	_____	_____
Gas	_____	_____	_____	_____	_____	_____	_____	_____
Oil	_____	_____	_____	_____	_____	_____	_____	_____
Kerosene	_____	_____	_____	_____	_____	_____	_____	_____
Wood	_____	_____	_____	_____	_____	_____	_____	_____
Other: _____	_____	_____	_____	_____	_____	_____	_____	_____

Average summer monthly bill: _____ Total Utility Bills: _____

No. of auxiliary heating units consumed (#cords, #therms, etc.):
 _____ kWh electricity _____ gallons of oil _____ cords of wood
 _____ therms of gas _____ gallons of kerosene _____ other: _____

Price paid per unit: _____ Total auxiliary heating bill: _____

#Btu's per unit: _____
 Total Number of Btu's consumed for auxiliary heating: _____

29a. Index of Energy Conservation:
 Total #Btu's divided by Square Footage + Heating Degree Days =

29b. How satisfied are you with the heating bills you had this past winter?
 Very dissatisfied Very satisfied
 1 2 3 4 5

OBSERVATION SCHEDULE

Checklist on Observation of Physical Traces

1. PERCEIVED COMPLEXITY (HYPO 1)

1. ___ evidence of modification of system to optimize or enhance the energy savings.
2. ___ evidence of modification of system which might interfere with energy savings.

Comment:

2. WILLINGNESS TO CONSERVE ENERGY (HYPO 5)

- ___ (1) furniture arranged around woodstove helps heat transfer.
- ___ (1) electric blankets, extra quilts (use rather than turn up thermostat)
- ___ (1) afghans, blankets, or warm clothing located in or adjacent to living area for warmth during cool periods.
- ___ (1) other:
- ___ (0) no evidence of willingness to conserve energy.

3. EFFECTIVE INTERIOR DESIGN TO CONSERVE ENERGY: (HYPO 6)

Interior Design:

Positive (+1)

1. ___ high reflectance finishes for non-mass surfaces.

2. ___ low reflectance finishes for mass surfaces.

3. ___ furnishings used as heat storage.
(i.e. ceramic table, etc.)

4. ___ south wall free from any major obstructions.

5. ___ all matte surfaces reduce reflected glare.

Negative (0)

1. ___ low reflectance finishes for non-mass surfaces help to overheat home.

2. ___ high reflectance finishes for mass surface doesn't store heat well.

3. ___ no evidence of furnishings used as heat storage.

4. ___ furniture obstructing south wall.

5. ___ shiny surfaces enhance reflected glare problem.

4. CONSISTENCY AND INTENSITY OF INVOLVEMENT WITH MAINTENANCE TASKS:

(HYPO 7)

- ☐ (1) evidence of "tinkering" i.e. construction projects to enhance system, i.e. shutters, solar collectors, etc.
- ☐ (1) shutters or window treatments show evidence of use
- ☐ (1) vents or fans show evidence of use.
- ☐ (1) other evidence:
- ☐ (0) no evidence of involvement with home (i.e. shutters look as if they are rarely used, or central air system only involves turning up thermostat)

Comments:

Total Score: _____

5. VOLUNTARY SIMPLICITY (HYPO 8)

- ☐ (1) refinishing furniture, carpentry work
 - ☐ (1) physical exercise (bicycle, weights, exercise mat, etc.)
 - ☐ (.5) ecological posters, Sierra Club calendars, Solar organization calendars.
 - ☐ (1) food preservation or vegetable gardening.
 - ☐ (1) recycling of cans, glass or newspapers
 - ☐ (.5) books on self-reliance, ecology, physical exercise, etc.
 - ☐ (1) other:
 - ☐ (0) no evidence of voluntary simplicity.
- Total:

6. SATISFACTION (HYPO 11)

evidence of dissatisfaction or dysfunctions:

- ☐ (0) restricted living room size creates congested living area.
- ☐ (0) furniture obstructs southwall because of restricted room size.
- ☐ (0) other evidence of dissatisfaction:

evidence of satisfaction:

- ☐ (1) seating arranged around woodstove for warmth and enjoyment.
- ☐ (1) comfortable chair in direct sunlight to enjoy sunlight.
- ☐ (1) other evidence of satisfaction:

APPENDIX C
SURVEY INSTRUMENT

No. _____

SELF-ADMINISTERED SURVEY (SA)

PLEASE INDICATE HOW STRONGLY YOU AGREE OR DISAGREE WITH THE FOLLOWING STATEMENTS BY CHECKING ONLY ONE BLANK FOR EACH STATEMENT:

1. Self-sufficiency is an important goal for our family.

_____	_____	_____	_____	_____
Strongly	Disagree	Neutral	Agree	Strongly
Disagree				Agree

2. Saving money is very important to us.

_____	_____	_____	_____	_____
Strongly	Disagree	Neutral	Agree	Strongly
Disagree				Agree

3. Using a renewable energy resource instead of fossil fuels is an important goal for our family.

_____	_____	_____	_____	_____
Strongly	Disagree	Neutral	Agree	Strongly
Disagree				Agree

4. Our home is compatible with the way we live.

_____	_____	_____	_____	_____
Strongly	Disagree	Neutral	Agree	Strongly
Disagree				Agree

5. If we were to buy another house, it would be different from this one.

_____	_____	_____	_____	_____
Strongly	Disagree	Neutral	Agree	Strongly
Disagree				Agree

6. Sometimes, we worry that we may lose money if we were to sell our house.

_____	_____	_____	_____	_____
Strongly	Disagree	Neutral	Agree	Strongly
Disagree				Agree

7. We are willing to go to a lot of trouble to conserve energy.

Strongly Disagree Disagree Neutral Agree Strongly Agree

8. Our house is comfortably warm in the wintertime.

Strongly Disagree Disagree Neutral Agree Strongly Agree

9. Our house is comfortably cool in the summer.

Strongly Disagree Disagree Neutral Agree Strongly Agree

10. Our house has saved us a lot on energy bills.

Strongly Disagree Disagree Neutral Agree Strongly Agree

11. We are very happy with our home.

Strongly Disagree Disagree Neutral Agree Strongly Agree

12. We sometimes find we do not have the time to do the solar maintenance tasks.

Strongly Disagree Disagree Neutral Agree Strongly Agree

13. We are consistent in performing solar maintenance tasks for our home.

Strongly Disagree Disagree Neutral Agree Strongly Agree

14. We especially enjoy the sunlight on the interior of our home.

Strongly Disagree Disagree Neutral Agree Strongly Agree

15. New ideas are very exciting to me.

Strongly Disagree Disagree Neutral Agree Strongly Agree

(NOTE: Question 16 and 17 were sent to survey only sample.)

16. How many years have you lived in your house? _____

When was your house built? _____

What type of solar system does your house contain? Check all that apply.

- _____ Direct gain
- _____ Indirect gain (such as Trombe wall, waterwall, Rodwall, etc.)
- _____ Greenhouse or sunspace
- _____ Active heating system
- _____ Active hot water heating system
- _____ Other, please describe:

17. Check any of the following statements which most accurately reflects your involvement in the design and construction of your house.

- _____ House was already built and finished when purchased so was not involved in design or construction.
- _____ Selected or helped select wall, floor finishes, or cabinetry.
- _____ Worked with designer on floor plan and/or solar features.
- _____ Designed floor plan and/or solar features.
- _____ Contributed physical labor during construction.
- _____ Did most of the actual construction of the house.

Check any of the statements which reflect your involvement with the operation of your home.

- _____ No maintenance tasks for passive solar system.
- _____ Opening/closing shutters or shades (less than 5 mins. daily).
- _____ Opening/closing shutters or shades (about 10 mins. daily).
- _____ Opening/closing shutters or shades (over 10 mins. daily).
- _____ Operating vents or fans.
- _____ Seasonally adjusting or applying shading devices.
- _____ Operating woodstove.
- _____ Making repairs or adjustments to system.

Please indicate household members' sex and age:

Sex	Age
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

FOLLOWING ARE A FEW QUESTIONS ABOUT YOU AND YOUR HOUSEHOLD.

18. Does anyone in your household own any of the following?
(CHECK ALL THAT APPLY)
1. ☐ Video game
 2. ☐ Home computer
 3. ☐ Microwave oven
 4. ☐ Solar toys and gadgets (calculators, wristwatches, etc.)
19. Which of the following activities have you engaged in during the last year? (CHECK ALL THAT APPLY)
1. ☐ (1) Worked with others to help solve community problems
 2. ☐ (1) Contacted political officials or politicians
 3. ☐ (3) Ran for political office
 4. ☐ (1) Wrote a letter to the editor
 5. ☐ (2) Made a speech
 6. ☐ (2) Worked on a political campaign
 7. ☐ (2) Wrote an article
 8. ☐ (2) Was an officer of a community organization
 9. ☐ (1) Signed a petition
 10. ☐ (1) Often gave friends and neighbors advice
 11. ☐ (0) None of these

WE NEED TO KNOW SOMETHING ABOUT YOUR FAMILY INCOME. THIS INFORMATION IS ANONYMOUS AND WILL NOT HAVE YOUR NAME ASSOCIATED WITH IT IN ANYWAY. IT WILL BE USED ONLY TO GROUP PEOPLE TOGETHER WHO HAVE SIMILAR INCOMES.

20. Please check off which category best represents the total annual income, before taxes, of your immediate family living in your household?
1. ☐ Under \$5000 a year (or under \$96/wk.)
 2. ☐ \$5000-\$6999 a year (or \$96-\$134.50/wk.)
 3. ☐ \$7000-\$9999 a year (or \$135-\$192.50/wk.)
 4. ☐ \$10,000-\$11,999 a year (or \$193-\$229.50/wk.)
 5. ☐ \$12,000-\$14,999 a year (or \$230-\$288.50/wk.)
 6. ☐ \$15,000-\$19,999 a year (or \$289-\$383.50/wk.)
 7. ☐ \$20,000-\$24,999 a year (or \$384-\$480.50/wk.)
 8. ☐ \$25,000-\$34,999 a year (or \$481-\$672.50/wk.)
 9. ☐ \$35,000-\$44,999 a year (or \$673-\$864.50/wk.)
 10. ☐ \$45,000-\$54,999 a year (or \$865-\$1056.50/wk.)
 11. ☐ Over \$55,000 a year (or over \$1057/wk.)

21. Please check off which one of the following categories most nearly describes the kind of work the chief wage earner in your immediate family does. (IF CHIEF WAGE EARNER IS UNEMPLOYED, CHECK OFF WHAT TYPE OF WORK HE/SHE WOULD DO IF EMPLOYED.) (CHECK ONE)
1. ☐ PROFESSIONAL WORKER: e.g. lawyer, doctor, scientist, teacher, systems analyst, musician, etc.
 2. ☐ WORKS AT A SKILLED TRADE OR CRAFT: e.g., printer, baker, tailor, RR engineer, plumber, or does mechanical work such as garage mechanic, carpenter.
 3. ☐ SEMI-SKILLED WORKER: e.g. operates a machine in a factory, is an assembly-line worker in a factory, drives a truck, taxi.
 4. ☐ MANAGER, EXECUTIVE, OR OFFICIAL: in business, government agency, or other organization.
 5. ☐ RUNS OWN BUSINESS WITH ONE OR MORE EMPLOYEES: e.g., store, factory, plumbing, contractor, etc.
 6. ☐ FARM OWNER, FARM MANAGER
 7. ☐ CLERICAL OR OFFICE WORKER: in business, government agency, or other type of organization, e.g. typist, secretary, postal
 8. ☐ SALES WORKER: e.g., a clerk in a store or a door-to-door salesperson
 9. ☐ MANUFACTURER'S REPRESENTATIVE: e.g., outside salesperson, salesperson.
 10. ☐ SERVICE WORKER WHO PERFORMS SERVICES: e.g., policeman, fireman, waiter, maid, or barber.
 11. ☐ LABORING WORKER (other than farm): e.g. plumber's assistant, construction laborer, longshore
 12. ☐ FARM LABORER, FARM HELPER, OR FARM FOREMAN
 13. ☐ RETIRED
 14. ☐ FULL-TIME STUDENT
 15. ☐ HOUSEWIFE
 16. ☐ OTHER (please specify) _____
22. What is the highest level of education you have completed? (CHECK ONE)
- | | |
|---|---|
| 1. ☐ Less than high school | 4. ☐ Some college |
| 2. ☐ High school graduate | 5. ☐ College graduate |
| 3. ☐ Trade or technical school | 6. ☐ Graduate work or more |

HERE IS A SET OF STATEMENTS ABOUT ACTIVITIES THAT SOME PEOPLE ENGAGE IN.
PLEASE INDICATE WHETHER AND HOW MUCH YOU OR MEMBERS OF YOUR HOUSEHOLD
ENGAGE IN THESE ACTIVITIES

23. Use a bicycle for transportation or recreation (CHECK ONE)
1. ☐ Very frequently ride bicycle.
 2. ☐ Frequently ride bicycle.
 3. ☐ Sometimes ride bicycle.
 4. ☐ Never ride bicycle.
24. Recycle the newspapers, glass, or cans used at home. (CHECK ONE)
1. ☐ Recycle all of this material.
 2. ☐ Most of this material.
 3. ☐ About half of this material.
 4. ☐ Some of this material.
 5. ☐ Never recycle.
25. Developing and using skills to increase self-reliance, such as in carpentry, car, repair, food preservation. (CHECK ONE)
1. ☐ Very frequently use these skills.
 2. ☐ Frequently use these skills.
 3. ☐ Sometimes use these skills.
 4. ☐ Rarely use these skills.
26. Buying clothing at a garage sale or second-hand store. (CHECK ONE)
1. ☐ All of the household's clothing.
 2. ☐ Most items.
 3. ☐ About half of the household's clothing.
 4. ☐ A few items.
 5. ☐ None of the household's clothing.
27. Contribute to ecologically-oriented organizations (such as the Sierra Club, etc. (CHECK ONE).
1. ☐ Contribute regularly to 2 or more organizations.
 2. ☐ Contribute regularly to 1 organization.
 3. ☐ Occasionally contribute.
 4. ☐ Used to contribute, but no longer do.
 5. ☐ Never have contributed.
28. Engage in exercise for physical fitness (e.g. running, swimming, calisthenics, etc.)
1. ☐ Very frequently exercise.
 2. ☐ Frequently exercise.
 3. ☐ Sometimes exercise.
 4. ☐ Rarely exercise.

HOUSING SATISFACTION SCALE

FOR EACH OF THE FOLLOWING HOUSING CHARACTERISTICS RATE HOW IMPORTANT EACH FEATURE IS TO YOU. THEN RATE HOW SATISFIED YOU ARE WITH THE FEATURE. RATE THE IMPORTANCE OF THE FEATURE ON A SCALE OF 1 THROUGH 6 (1 INDICATES VERY UNIMPORTANT; 6 INDICATES VERY IMPORTANT). YOUR SATISFACTION WITH THE FEATURE SHOULD ALSO BE RATED ON A SCALE OF 1 THROUGH 6 (1 INDICATES VERY DISSATISFIED; 6 INDICATES VERY SATISFIED).

VERY UNIMPORTANT						VERY IMPORTANT						VERY DISSATISFIED						VERY SATISFIED					
1	2	3	4	5	6	1. LAYOUT OF FLOOR PLAN: Privacy for family members (1a).	1	2	3	4	5	6											
1	2	3	4	5	6	Separation of children and parent areas (1b).	1	2	3	4	5	6											
1	2	3	4	5	6	Number of rooms (1c).	1	2	3	4	5	6											
1	2	3	4	5	6	Arrangement of rooms (1d).	1	2	3	4	5	6											
1	2	3	4	5	6	2. STORAGE: Closet space in master bedroom (2a).	1	2	3	4	5	6											
1	2	3	4	5	6	Closet space in other bedrooms (2b).	1	2	3	4	5	6											
1	2	3	4	5	6	Storage for household linens (2c).	1	2	3	4	5	6											
1	2	3	4	5	6	Storage for cleaning equipment and supplies (2d).	1	2	3	4	5	6											
1	2	3	4	5	6	Storage at entry (2e).	1	2	3	4	5	6											
1	2	3	4	5	6	Storage space in bath (2f).	1	2	3	4	5	6											
						3. LIVING ROOM (note: if house has family room or recreation room, refer to room family uses most for family activities, i.e. tv-watching, etc.)																	
1	2	3	4	5	6	Flexibility in arrangement of furniture (3a).	1	2	3	4	5	6											
1	2	3	4	5	6	Size of living area (3b).	1	2	3	4	5	6											
1	2	3	4	5	6	Floor coverings (3c).	1	2	3	4	5	6											

VERY UNIMPORTANT						VERY IMPORTANT						VERY DISSATISFIED						VERY SATISFIED					
1	2	3	4	5	6	4. DINING: Size of dining space (4a).	1	2	3	4	5	6	1	2	3	4	5	6					
1	2	3	4	5	6	Location of dining area(s) (4b).	1	2	3	4	5	6	1	2	3	4	5	6					
1	2	3	4	5	6	Floor coverings (4c).	1	2	3	4	5	6	1	2	3	4	5	6					
1	2	3	4	5	6	Flexibility of furniture arrangement (4d).	1	2	3	4	5	6	1	2	3	4	5	6					
1	2	3	4	5	6	5. KITCHEN: Amount of counter space (5a).	1	2	3	4	5	6	1	2	3	4	5	6					
1	2	3	4	5	6	Amount of storage space (5b).	1	2	3	4	5	6	1	2	3	4	5	6					
1	2	3	4	5	6	Arrangment of work space (5c).	1	2	3	4	5	6	1	2	3	4	5	6					
1	2	3	4	5	6	6. BEDROOMS: Number of bedrooms (6a).	1	2	3	4	5	6	1	2	3	4	5	6					
1	2	3	4	5	6	Flexibility in arranging furniture in master bedroom (6b).	1	2	3	4	5	6	1	2	3	4	5	6					
1	2	3	4	5	6	Flexibility in arranging furniture in other bedrooms (6c).	1	2	3	4	5	6	1	2	3	4	5	6					
1	2	3	4	5	6	Size of master bedroom (6d).	1	2	3	4	5	6	1	2	3	4	5	6					
1	2	3	4	5	6	Size of other bedrooms (6e).	1	2	3	4	5	6	1	2	3	4	5	6					
1	2	3	4	5	6	7. BATH: Number of bathrooms (7a).	1	2	3	4	5	6	1	2	3	4	5	6					
1	2	3	4	5	6	Size of bathroom(s) (7b).	1	2	3	4	5	6	1	2	3	4	5	6					
1	2	3	4	5	6	Arrangement of bathroom fixtures (7c).	1	2	3	4	5	6	1	2	3	4	5	6					

VITA

Joan McLain-Kark was born in St. Louis, Missouri and attended elementary and high schools in Missouri. She received a bachelor of science degree majoring in housing and interior design from the University of Missouri at Columbia in 1971. She worked as a commercial interior designer in Kansas City and Columbia from 1971 through 1974 and as a residential interior designer in Fayetteville, Arkansas from 1977 through 1978. She taught as an adjunct faculty member at the University of Missouri in 1974. In 1979, she received a master of science degree in housing and interior design from the University of Missouri. From there, she held the position as interior design instructor at the University of Northern Iowa from 1979 to 1980. She joined the interior design faculty at Virginia Polytechnic Institute and State University in 1980 where she presently is an assistant professor.

Ms. McLain-Kark has published articles on interior design education, energy research, and computer applications for the Journal of Interior Design Education Research, Progress in Solar Energy, and Progress in Passive Solar Energy Systems. Her passive solar housing design won first place in the interior architecture category of the National Endowment of the Arts Competition "Integrated Design for Clothing, Interiors and Housing" in 1982. Her

professional memberships include the Interior Design Educators Council, American Home Economics Association, American Solar Energy Society, and the American Society of Interior Designers. While at the University of Tennessee, she was initiated into Phi Kappa Phi.