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Title: Housing for Nuclear and Single Parent Families: A Comparison by Two Methods.

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The vast majority of housing in the United States today has been created to conform to a family definition that does not match current demographic realities. The "traditional family" - a married couple with an employed husband, a homemaker wife, and several children - has been the model family that housing designers have strived to accommodate on a grand scale since at least the mid-1940's. This type of family, however, comprises only 10% of all American families; the remaining 90%, despite being a majority, have had their housing needs ignored. One family group often considered to be non-traditional and often left out of housing considerations is the single parent family. This family type is an established household form in the United States; currently nearly one third of all American families are single parent families, most of which are headed by women.

During the past few years housing projects have begun to appear that are designed to house "non-traditional families" such as single parent families. It has been generally assumed that the spatial needs of single parent families are different from those of nuclear families

or the "traditional family". This research will focus on the analysis of housing as designed for single parent families in comparison to housing as designed for the American nuclear family. Floor plans of the two housing types were obtained from the following cities: Denver, CO, Hayward, CA, Providence, RI, and Minneapolis, MN.

The intent of this study is to examine what, if any, differences occur in the spatial orientation of housing designed for single parent families and housing designed for the nuclear family: the single family detached home. The study examined room layout in relation to use and commonly accepted social function. Two methods of analysis were employed: gamma analysis as developed by Hillier and Hanson and annotated analysis developed specifically for this research. The method of gamma analysis was used to determine if the housing as designed for the two family types is different in form and social function, while the annotated analysis was used to measure the "fit" of the housing for each of the family types.

It was originally expected that the single parent family dwellings would exhibit a higher degree of integration than the single family detached homes based on predictions gleaned form the literature. However, the gamma analysis revealed a lower mean relative asymmetry value for the single family detached houses (0.308), indicating a higher degree of integration, than the mean relative asymmetry value for the single parent family dwellings (0.368). This difference was not found to be significant ($p = 0.276$). The annotated analysis results indicated single family detached houses scored a better fit to their intended family type (mean annotated analysis score = 0.638) than did the single parent family dwellings to their intended family type (mean annotated

analysis score = 0.533). Again, this difference was not found to be significant ($p = 0.385$).

The findings of this study provide a glimpse at the interior spatial arrangements of housing as designed for the two family types in question. While the results of the two analysis methods seems to indicate that the interior spatial arrangement of housing is not meeting the needs of either family type, more research should be conducted to further substantiate the findings. These findings will be of interest to designers of homes, housing developers, planners and policy makers, and researchers in the field of housing, all of whom can have an effect on the shape of the housing environment and can help make it more suitable for all family types.

Housing for Nuclear and Single Parent Families: A Comparison by Two Methods

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TABLE OF CONTENTS

LIST OF FIGURES

Housing for Nuclear and Single Parent Families: A Comparison by Two Methods

CHAPTER I

INTRODUCTION

Problem Statement

The vast majority of housing in the United States today has been created to conform to a family definition that does not match current demographic realities. The traditional family - a married couple with an employed husband, a homemaker wife, and several children - has been the model family that housing designers have strived to accommodate on a grand scale since at least the mid-1940's (Hayden, 1984). This type of family, however, comprises only 10% of all American families; the remaining 90%, despite being a majority, have had their housing needs ignored (Ahrentzen, 1989).

One family group often considered to be non-traditional and often left out of housing considerations is the single parent family. This family type is an established household form in the United States. The proportion of single parent families in the United States in 1970 was roughly equal to the proportion of single parent families in 1870 (Seward, 1978). During the decade between 1970 and 1980, however, the proportion of single parent families doubled (Ahrentzen, 1989). Birch (1985) found that currently nearly one third of all American families are single parent families. The number of single parent families is expected to increase based on the increasing number of births to single women and the high divorce rate (U.S. Bureau of

Census, 1990). Approximately 22 percent of all births in 1985 were to single women, as opposed to 4 percent in 1950 (USNCHS, 1985). Female headed, single parent families in particular face more housing problems due to the low economic status of women and patterns of discrimination in the housing market (Birch, 1985).

During the past few years housing projects have begun to appear that are purportedly designed to house non-traditional families such as single parents. Quantitative analysis of the housing designed for single parent families in comparison to housing designed for the traditional nuclear American family can be used to test the fit of the dwelling space to these populations.

Purpose of the Study

The intent of this study is to examine what, if any, differences occur in the spatial orientation of housing designed for single parent families and housing designed for the nuclear family. The study will examine room layout in relation to use and commonly accepted social function. Two methods of analysis will be employed: gamma analysis as developed by Hillier and Hanson in 1984 and annotated analysis developed specifically for this research. The method of gamma analysis (Hillier & Hanson, 1984) will be used to determine if the housing as designed for the two family types is different in form and social function, while the annotated analysis will be used to measure the "fit" of the housing for each of the family types. The findings of this study will provide a glimpse at what, if any, spatial changes occur in housing designed for the two family types in question.

Furthermore the research will begin to assess the specific social logic of the housing forms.

Objectives

The objectives of this study are:

1. To establish a single family detached house and a single parent family dwelling checklist for the annotation analysis (Appendices A - D) in order to determine the fit of the housing for each family type.

2. To evaluate the floor plans pertinent to the study with the checklists in order to determine if the houses meet the needs of the family types in question.

3. To determine predicted values of relative asymmetry (Hillier & Hanson, 1984) based on the annotation analysis.

4. To use the method of gamma analysis (Hillier & Hanson, 1984) to determine if the distribution of rooms within the dwelling unit of each type of housing is different.

5. To compare the findings of the two analysis methods.

6. To discuss the implications of these findings in terms of social expectations and attitudes surrounding the populations in question.

Limitations

1. The study is limited to the examination of housing for single parent families and single family detached housing in Denver, CO, Providence, RI, and Minneapolis, MN. This limitation is due to the small number of cities with housing designed specifically for single parent families.

2. Single family detached house plans were received from Century-21 offices in each of the three cities mentioned above. The study is limited by the extent that the real estate agents understood and responded to the request for these plans.

3. The study will examine only the housing forms (only the floor plans) and not the location of the housing forms in relation to services or neighborhood types. It recognized however, that the juxtaposition of housing and services, particularly for single parent families, is extremely important.

4. A true comparison of neighborhoods is additionally difficult because most housing for single parent families is located in the inner city, whereas most single family detached housing is located in the suburban rings of cities.

5. The vast differences in the economic meaning of "starter" home in each of the cities examined create a limitation for the study.

CHAPTER II

REVIEW OF LITERATURE

Introduction

Architecture gives shape and form to our material world (Hillier & Hanson, 1984), structuring the space in which we move. Through this structuring architecture has a direct relation to social life - it contributes the material world in which social life takes place, and sometimes generates social life. In this manner, architecture pervades our lives on more than simply a visual level. This is especially true for housing, the architecture in which the most personal activities of family life take place. Housing as a spatial form is much more than abstract shelter, it is a form of architecture that to a certain extent defines and describes its inhabitants (Rapoport, 1969). For the purposes of this essay the space to be considered is the space of the house and home. As spatial entities both house and home are full of social meaning (Hillier & Hanson, 1984). Lawrence (1987) described the house as "... a physical unit that defines and delimits space for the members of a household" (p. 155). A home, however, is more complex, it is an "...entity that defines and is defined by cultural, socio-demographic, psychological, political, and economic factors" (Lawrence, 1987, p. 155). A house however, is not simply a benign shelter. A house is much more than shelter and can be construed as being culturally defining (Hayden, 1984; Rapoport, 1969). The two family types under consideration will be represented by a type of housing assumed to serve it's respective spatial needs; the single family detached house for the nuclear

family, and housing claimed to be designed specifically with the single parent family in mind. These houses will be examined in two ways, first through an annotated analysis procedure, to test the assumption of fit; and then through the application of Hillier and Hanson's (1984) gamma analysis, as a quantitative method of comparison.

However, before an examination of spaces can begin, the connection of a housing type with a family type must be established. Family type is as much a human construction as is housing. One form is more physically visible than the other but both are social constructions that order our environment (Franck, 1985). At any given time in history ideas about family will determine the design and location of buildings (Wright, 1981). Societal ideas about the ideal family and appropriate activities for each gender affect built forms in such a way as to perpetuate and support those ideals, making it difficult for persons with lifestyles contrary to the accepted ideal to function within these environments (Franck, 1985).

A brief discussion of each family type, the single parent family and the nuclear family, the housing associated with it and the nature of that housing will be presented in this chapter. This will be followed by an examination of the methods of analysis to be used to uncover the social meaning of the housing.

Nuclear Families: Origins and Housing Form

Origins

Until recently the American family was thought to be composed of a male wage earner, female homemaker, and two or more children (Van

Allsburg, 1986). This family is commonly referred to as the traditional nuclear family. It is argued that this family type is relatively new (Ahrentzen, 1989; Ewen, 1976; Gerson, 1983; Hayden, 1984; Lamb, 1982; Seward, 1978). There has been a belief that the traditional nuclear family, over all other family types, is most likely to preserve marital harmony and raise psychologically healthy children (Lamb, 1982). This family form first emerged as recently as the mid to late nineteenth century, during which the industrial revolution secured for men a "living wage" (Gerson, 1983). Up until this time the middle class did not exist in significant numbers and the consumer culture had not yet fully developed (Ewen, 1978; Handlin, 1979). With the new industrialization, it was no longer necessary or even advantageous for women and children to do wage work, in fact women and children who were once encouraged to engage in factory or field work were now being taught the new skill of domesticity (Hayden, 1984). The idea of a woman in the home to provide a "haven" for her harried husband, to promote in her children the latest Victorian moral concerns, and to consume the ever increasing number of products the industrial revolution could turn out was attractive to industry. Industry helped promote home ownership for male workers only, individual appliances for each home, and an overall need to furnish the home in a restful and tasteful manner (Hayden, 1984; Wright, 1981). These plans were carried out through programs such as "Homes for Workmen" in 1919 (Wright, 1981) and "Selling Mrs. Consumer" in 1929 (Hayden, 1984) and rallied around slogans such as "good homes make contented workers" (Hayden, 1981). As early as 1869, Catherine

Beecher was proposing and supporting the home as the woman's sphere, and the wage labor world as the men's arena (Beecher, 1869), in effect backing the moves of industry to create a consumer culture.

The aspirations of industry had an effect on family form to the extent that these programs created the traditional nuclear family among the middle classes. By promoting the segregation of housing from work sites, industry was able to create the need for a family unit that required one parent to be home with children and one parent to be earning a wage. In addition, the promotion of consumption over production as the family activity helped lead to the ideal of the traditional nuclear family (Seward, 1978) spurred on by a variety of tracts from religious organizations, women's magazines, and governmental policies (Hayden, 1984; Wright, 1981). Seward (1978) further points out that it is generally accepted that "...the small nuclear family is necessitated by certain characteristics of industrialization" (p. 136). One of the most significant of these characteristics is the separation of work and home life (Kammerman, 1979). An adjustment to this traditional nuclear family has been gaining momentum over the past twenty years as more and more married women enter the paid labor force (Gerson, 1983). This family type will be referred to here as simply the nuclear family. Despite the increase of women in the paid labor force (up from 18% in 1950 to 52% in 1980 (Van Allsburg, 1986)) adjustments in the physical space of housing have been slow (Hasell & Peatross, 1990).

Housing Form

Housing and cities since at least the turn of the century, and even more so since the Second World War, have been designed to accommodate the traditional nuclear family type (Gray, 1946; Hayden, 1981, 1984; Wright, 1981). The environment, particularly the housing environment as designed in the past 50 or 60 years in the United States, has relied on a vision of all Americans as belonging to a traditional nuclear family as its model for the design of homes (Hayden, 1984). Literature from the turn of the century, such as Beecher (1869), and on into the twentieth century (Agan, 1939, 1956; Gray, 1946; Halbert, 1931; Talcott, Helper & Wallach, 1986) describe families both explicitly and implicitly in terms of the nuclear model. Rodgers (1962) explicitly states the gender defined roles that have come to be associated with the traditional nuclear family. As a result our houses are designed with an assumption of certain activities that take place within them and with certain relationships between the persons in the house. The American suburban home, as well as the larger suburban community, is designed to support a gender system characterized by a division of labor and a segregation of people by sex (Franck, 1985; Saegert, 1980). Saegert (1980) points out the common social equation of men with cities and women with suburbs. Citing the use of such terms as aggressive, assertive, intellectual, and powerful to describe men and cities; and domesticity, repose, mindlessness, and lack of seriousness to describe women and suburbs, she underlines the expectations that women would pursue homemaking, and men breadwinning. The separation of the arenas

of men and women, cities and suburbs, and the worlds of wage work and housework, were most fully articulated in the design of the detached single family home (Franck, 1985).

A Brief History of Single Family Detached Housing

The rise of industrialization, coupled with the new advertising industry, supported the ideal of mass consumption and promoted the private suburban dwelling, the single family detached home (Hayden, 1981). This dwelling type, and the gender division of space that it supports, was facilitated by the legalization of zoning in 1926 (Village of Euclid v. Ambler Realty Co., 1926), allowing American municipalities to enact ordinances regulating and separating land uses (Ritzdorf, 1988). The legalization of zoning provided the mandate to physically separate the work place from residential areas, essentially reinforcing the Victorian moral ideal of the isolation of the traditional nuclear family away from the harried pace of the working world[1] (Wright, No Date). The Supreme Court Case of the Village of Euclid v. Ambler Realty Co. (1926) placed single family residential areas as the most exclusive land use areas, prohibiting all other land uses in those zones. This set the stage for more public policies which provided incentives to developers, financiers, and purchasers of single family detached homes. Through the 1930's, the federal government was involved in financing and constructing a sizeable segment of American housing. It was also involved in policies

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[1] During the 1920's the City of Berkeley, CA, at the request of local manufacturers, made it illegal to place residences in a business area (Wright, 1981), becoming the first United States city to do this.

designed to stabilize the traditional nuclear family and to perpetuate an orderly, ie. segregated and zoned, pattern of development (Wright, 1981). The standards set by the government for construction, financing, and land use planning also set standards for family and community life.

An early movement that explicitly described housing form in relation to family and gender roles was "Better Homes in America, Inc." (Hayden, 1984). "Better Homes in America" was a cooperative effort between the federal government and private enterprise with then United States President Herbert Hoover serving as the organization's president. The group sponsored classes, demonstrations, conferences, and publications related to supporting the ideal of the traditional nuclear family in the suburban single family detached home (Halbert, 1931). "Better Homes in America" tackled such issues as good citizenship, sanitation, racial strife, and communist threat through the promotion of the suburban single family detached home and the conviction that wholesome home life could solve these problems (Halbert, 1931; Wright, 1981). "Better Homes" enthusiasts focused on rural and suburban locations, emphasizing gender roles along with housing form. "Better Homes in America" provided the spatial setting for the ideal traditional nuclear family during the 1930's. The new advertising industry aided the "Better Homes" movement by emphasizing the products that would ensure a happy, close knit family (Wright, 1981). All of this contributed to the development of the ideal of the traditional nuclear family as the one for all Americans to emulate,

elevating this family type to such prominence that any other family constellation simply was not visible.

The federal government all but legislated this as the official family type in the United States with the establishment of the Federal Housing Administration (FHA) standards in the 1930's. The FHA was set up in 1934 to stimulate the private housing market. The FHA provided loans of up to 80% of a home's value, 20 year maturities, 5% to 6% interest, and small monthly payments[2]. All loans made by bankers under FHA terms were insured for payment by the federal government. In addition to financial support to families (and financiers) interested in the detached single family home, the FHA established design controls in an effort to stabilize neighborhoods (Wright, 1981). The agency endorsed zoning to prevent multifamily dwellings and insisted that no FHA financed single family detached home would have facilities to allow it to be used for wage work such as offices, shops, or day care for children.[3] The FHA home could not be used as a rental unit. The FHA further accepted and endorsed restrictive covenants that ensured neighborhood homogeneity and attractiveness through the control of the race and ethnicity of residents (Federal Housing Administration, 1959; Gray, 1946; Wright, 1981).

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[2] Prior to the FHA financing, loans were available for up to 50% of a home's value, came with high interest rates, and could be "called" at any time, requiring the home owner to either pay the loan in full or vacate the home.

[3] The free day care provided by the homemaker to her own children was, however, supported.

Design guidelines on FHA homes not only involved the neighborhood but also the interior arrangement and types of rooms a home would have. Dwelling quality and size, architectural control and building location were also enforced through covenants in the sale deed (Federal Housing Administration, 1959). The FHA was very interested in protecting the resale value of the homes it insured and because of this the Administration took a conservative stance on architectural style and construction (Gray, 1946). It was felt that the traditional styles in architecture would best lend themselves not only to future sale but also to instilling an improved sense of civic responsibility in inhabitants (Gray, 1946). The FHA preference for controlled, segregated suburban developments helped spur the post World War II housing boom. By 1957, the FHA had financed 4.5 million suburban homes (Wright, 1981). Housing in the United States continues to offer spaces that best serve the traditional nuclear family. Hayden (1984) states that three quarters of all United States housing stock has been built since 1940, and two-thirds of that stock is single family detached housing. Despite shrinking family size, the size of this housing has been increasing since the Second World War (Hasell & Peatross, 1990); 84% of this housing had five or more rooms in 1976 (Hayden, 1984).

By tracing the history of the development of the single family detached home there can be seen a history of architecture and planning since the mid-nineteenth century that implicitly assumes that men work

away from the home and women work in the home[4]. Programs, both public and private, have worked to separate the public realm of wage work from the private realm of the home (Beecher, 1869; Hayden, 1981; Wright, 1981). Jackson (1985) contends that the single family detached home, particularly the home located in the suburbs, is a manifestation of fundamental characteristics of American culture, and is especially a manifestation of the nuclear family. The suburban ideal of the single family detached house and the ideal of domesticity and the focus on family emerged at about the same time, in the mid-nineteenth century (Marsh, 1990). These were separate ideologies, both responses to industrialization. The suburban ideal was male defined, the domestic ideal female defined (Marsh, 1990). Early domestic reformers sought to free women from the drudgery of housework while maintaining an urban base of operations, while the ideal of suburbanization focused on Jeffersonian political philosophy of land ownership and stewardship. The two became entangled as industrialization grew and suburbs became more "civilized" and offered more sanitation amenities. Eventually advocates of both domestic reform and suburbanization became convinced the city was detrimental to family life and American political values (Marsh, 1990) and the

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[4] This is seen in the literature, especially the pre-1970 literature, through the use of gender based pronouns. All activities except those of the homemaker are described with the pronoun "he". The homemakers activities are described with the feminine pronoun, "she". The male pronoun has been used in the past to refer to all people, but it is interesting to note the more infrequent female pronoun in use only in reference to homemaking activities (ie. only women are homemakers).

ideal of the suburban family home was born. The spaces that make up this home have changed over time (Hasell & Peatross, 1990) but more due to technological advances than to new ideas about home and family (Rock, Torre & Wright, 1980).

The Space of the Nuclear Family: The Single Family Detached House

Most literature that discusses "the house" discusses the single family detached suburban house. This form has become so much a part of American collective consciousness that it is often forgotten that other forms of housing exist (Hayden, 1984). Text books on "residential design" often focus exclusively on the single family detached house and the nuclear family that will reside in it (Talcott, Helper & Wallach, 1986).

The phenomenon of single family detached housing has been outlined above in an historical sense, the mass popularity of this housing form beginning in the mid to late nineteenth century. Some of the earliest homes of white settlers in the United States were little more than shelter, the residents being more interested in forming a new government and practicing religion, but during the late eighteenth and early nineteenth centuries attitudes toward homes began to change (Handlin, 1979). Domestic architecture gained standing and discussions of what a house should be became widespread (Clark, 1986; Handlin, 1979). These discussions led to a plethora of pattern books and advice manuals on what makes a good home (Clark, 1986; Handlin, 1979; Wright, 1981). As in earlier times, literature exists today

that describes the "shoulds" of typical single family detached homes.[5] Some of the advice presented in the literature today is explicitly stated as being aimed at the nuclear family, (Rodgers, 1962; Talcott, Helper & Wallach, 1986) while other advice is presented more covertly through room type and layout.

Specific Spaces

In order to quantify the spaces of the single family detached house, only the core or central rooms will be considered for this analysis. Among the rooms and spaces considered most important in single family detached housing are: the entry (Talcott, Helper & Wallach, 1986), the living room (Rodgers, 1962), the family room (Zeisel & Welch, 1981), the kitchen (Rodgers, 1962; Talcott, Helper & Wallach, 1986; Zeisel & Welch, 1981), the dining room (Rodgers, 1962), the bedrooms and baths, and finally, the outdoor space. Each of the rooms are listed and described below. These features of the single family detached house have been taken specifically from house studies by Rodgers (1962), Talcott, Helper and Wallach (1986), and Zeisel and Welch (1981)[6], and are echoed throughout the vast popular literature on the single family detached house.

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[5] The literature that exists today is too vast to cite here as a trip to any magazine stand or book shop will attest. Shelter magazines and plan books of single family detached homes abound.

[6] It is interesting to note that the studies of Rodgers (1962), Talcott, Helper, & Wallach (1986) and Zeisel & Welch (1981) do not differ in their descriptions of the rooms and room uses of single family detached housing, despite a temporal separation of more than twenty years.

Entry. The entry of a house is a focal point (Talcott, Helper & Wallach, 1986). It should lead to the circulation areas to living, sleeping and service areas (Talcott, Helper & Wallach, 1986). There should be no direct view into any room from the entry (Talcott, Helper & Wallach, 1986).

Living room. The living room is considered the heart of the home. Rodgers (1962) uses only restful words to describe the living room. The room should facilitate a variety of family activities (Rodgers, 1962; Talcott, Helper & Wallach, 1986). The room should not be used as a pathway but should connect to the dining room and kitchen (Talcott, Helper & Wallach, 1986; Zeisel & Welch, 1981).

Family room. The family room should serve as a second and less formal living room (Rodgers, 1962; Talcott, Helper & Wallach, 1986; Zeisel & Welch, 1981). This room is optional and, if it does exist in a house, should be adjacent to the living room but separated from it by walls (Rodgers, 1962).

Kitchen. The kitchen should be easy to work in. It should be located close to the garage, front door, or other outdoor access (Rodgers, 1962; Talcott, Helper & Wallach, 1986). It should be directly accessible to the dining room (Rodgers, 1962; Talcott, Helper & Wallach, 1986; Zeisel & Welch, 1981). The literature generally does not describe the kitchen as needing to be near to major living areas to meet the needs of a nuclear family.

Dining room. Dining areas should be adjacent to the kitchen and the living areas (Rodgers, 1962; Talcott, Helper & Wallach, 1986).

Bedroom. The bedroom is the most personal room in the house and should, therefore, be awarded some degree of privacy. It should be near to bathrooms and offer sufficient space for non-sleeping activities (Rodgers, 1962; Talcott, Helper & Wallach, 1986). The bedroom should be located away from the main living areas (Rodgers, 1962). Children's bedrooms should provide playspace (Zeisel & Welch, 1981).

Bathroom. Bathrooms should be near bedrooms (Rodgers, 1962; Talcott, Helper & Wallach, 1986). Rodgers (1962) recommends one and a half baths for a family, while Talcott, Helper and Wallach (1986) recommend two or more.

Outdoor space. It is recommended that the primary outdoor space for a house be located at the back of the house to ensure maximum privacy (Rodgers, 1962). This space should be accessible from the kitchen and the living areas, yet secluded from the street (Talcott, Helper & Wallach, 1986).

These rooms have a definite hierarchy within the house. In 1888, Osborne listed the living room, entry and dining room as the public rooms of the family, the bedrooms and baths as the private rooms, and the kitchen as a service room. While these descriptions have been tempered somewhat in the recent literature, there are striking similarities to current room distinctions (Talcott, Helper & Wallach, 1986) and those of Osborne (1888). The public versus private and relaxation versus service distinctions are still being made. For example, Talcott, Helper, and Wallach (1986) do not include the kitchen as a part of the "living area". Despite vast social changes

(Gerson, 1983), the description of the single family detached house has changed little (Osborne, 1888; Talcott, Helper & Wallach, 1986).

Plans to be Analyzed

The descriptions offered above will be used to establish an annotated checklist to analyze the fit of a house plan to the nuclear family. The plans to be examined in this research are illustrated in the following Figures (Figs. 1-4). These plans were obtained from Century-21 real estate offices in each of the cities mentioned. They are considered to be typical starter homes for nuclear families. In Figure 1 two and three bedroom single family detached house plans from Denver, Co are illustrated.

The next plans (Figure 2) are houses from St. Paul, MN.

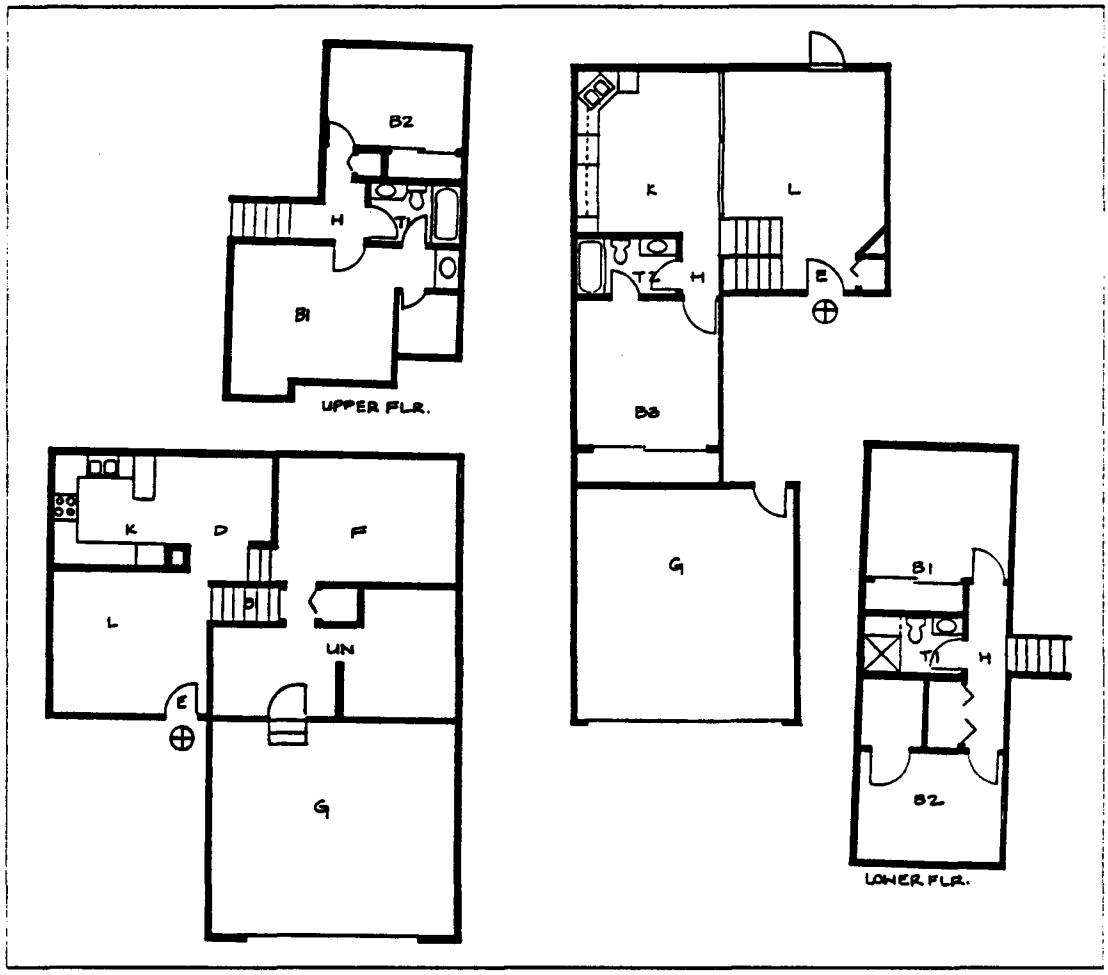


Figure 1. Single family detached home plans from Denver, CO.

Figure 3 illustrates a three bedroom plan from Providence, RI.

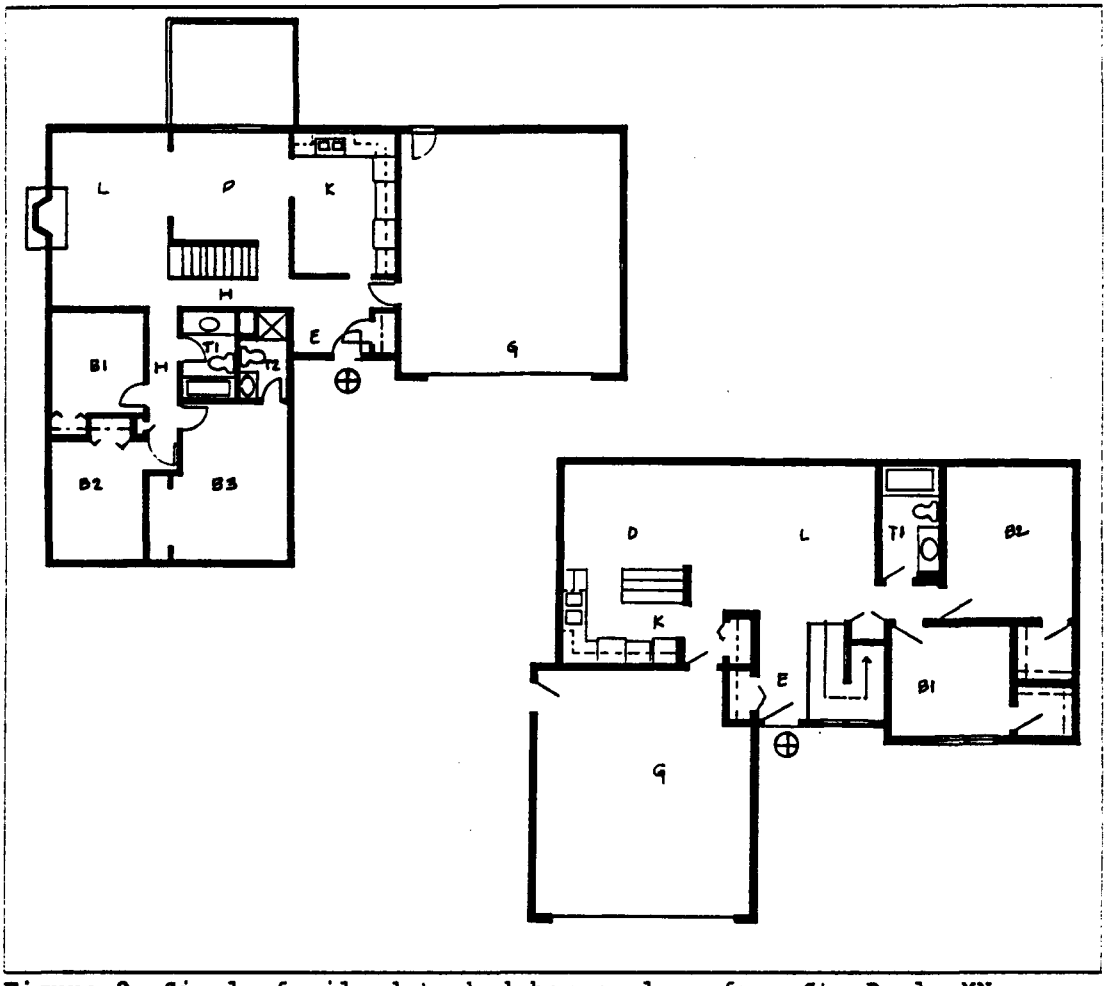


Figure 2. Single family detached house plans from St. Paul, MN.

Each of the above plans will be paired with and compared to a home designed for a single parent family. The homes will be matched for number of bedrooms and square footage.

Single Parent Families: Demographics and Housing Form

Demographics

If recognized at all, alternative family types, such as single parent families, were until recently thought of as deviants or social problems, or as only transitional families waiting to become the "traditional" ideal (Franck, 1985). However, Gerson (1983) points out

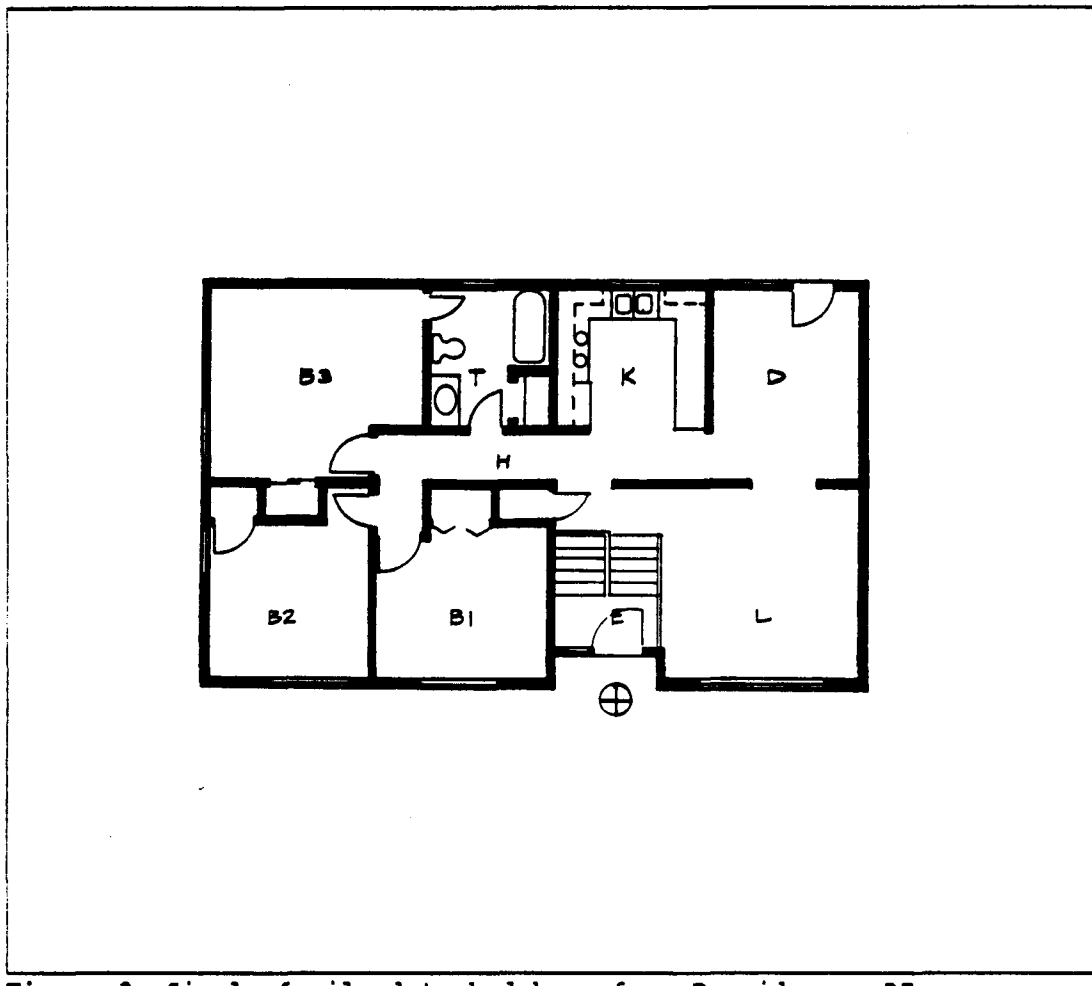


Figure 3. Single family detached home from Providence, RI.

that household composition[7], since at least 1950, has included a variety of family types. Seward (1978) found that proportion of single parent families in 1870 and 1970 were roughly equal, but between 1970 and 1980 this proportion increased greatly. Birch (1985) found that single parent families comprise approximately one third of all American families. This is in contrast to the traditional nuclear family that currently makes up only 10% of households in the United

[7] Gerson (1983) uses the terms "family" and "household" interchangeably.

States (Ahrentzen, 1989). Despite the demographics, housing and community design has ignored the non-traditional families in favor of the nuclear family model.

Housing Form

There is little literature on single parent families that has focused on ideas about housing configuration felt most appropriate for or on housing preferences of this family type. Authors Cook, Vogel-Hefferman, Lukermann, Pugh, and Wattenberg (1988) list appropriate policies and spatial arrangements for neighborhood design, management schemes, and housing layout for single parent families. While recognizing the complex nature of single parent families, Cook, et al. (1988) describe a community designed for this family type that promotes cooperative spaces, community interaction and accessible services while still maintaining privacy. Wekerle (1985) echoes this description of neighborhoods and housing for single parent families and women in general, seeing neighborhoods as combining work and family life and reducing the isolation of women in the home (Ahrentzen, 1989; Franck & Ahrentzen, 1989; Hayden, 1981; Leavitt, 1985; Soper, 1980; Wekerle, 1985). Cook and Rudd (1984) found that single parent families tend to live in urban areas, close to central business districts, and that in general this population has not participated to a great extent in the migration to the suburbs. This is held to be due to economic factors and discrimination in the housing market against women and, in particular, single parent families (Cook, 1988). Saegert (1985) has further stated that single parent families stress the importance of proximity to a variety of

facilities such as child care, parks, stores, and indoor recreational facilities, the same facilities that are often found near central business districts. New ideas about the family and its housing are not intended to eliminate private home life, but rather seek to support this private home life through community services to the household (Hayden, 1981).

The Space of Single Parent Families

The space of single parent families concerns not only the exterior of the house but the interior environment as well, and the cooperative nature of neighborhoods for single parent families spills over into the design of housing for this family type. The housing research by Cook, et al. (1988) provides a qualitative basis for the development of the annotated checklists to be used in the quantitative analysis in Chapter IV. Cook, et al. (1988) set out to research and develop strategies to provide appropriate housing and neighborhood design guidelines for single parent families. The result involves design, financing mechanisms, management, neighborhood and location, and support service suggestions. However the focus of this research will be on the interior arrangement of rooms in the housing designed for single parent families in an effort to determine if this housing serves the needs of the intended family; therefore only the design aspects of the research by Cook, et al. (1988) as it relates to floor plan and interior room arrangement will be examined here. Just as for the single family detached house, room descriptions are provided (Cook, et al., 1988). The spaces considered most important for single parents are the very same spaces that are found in the single family

detached house. The spaces of the single parent family are, however, described very differently.

Specific Spaces

Entry. Each unit should have its own entry that is clearly articulated. The entry should have a direct connection to the outdoors (if possible), immediate access to artificial lighting controls, access to the living room, proximity to circulation paths, and no visual connection to bedrooms or bathroom.

Living room. Living rooms should be close to the main entry, be able to accommodate a variety of furniture and activities, and have direct access to the outdoors.

Kitchen/dining. Kitchen areas should be large to accommodate children's needs as well as adults working in the area. The kitchen and dining room as one space is preferred. These spaces are often described in plans of prototype single parent family dwellings as central spaces (Franck & Ahrentzen, 1989).

Bedrooms. Bedrooms should be located away from the living areas to maximize privacy. These are best if arranged around a short corridor for ease of parental monitoring, and be either large enough to serve as play areas in the individual unit or have access to a space that can serve as a play area. Adult bedrooms should be private enough for activities other than sleeping.

Bathroom. Bathrooms should be located close to bedrooms and offer access from living areas as well.

Private outdoor space. Whenever possible each unit should have access to private outdoor space. This should be close to the main

living areas, have ground level access (no steps), and provide fencing to control small children. Private outdoor space is absent from most single parent dwellings due to cost.

Projects to be Analyzed

Design and architecture by prescription or one home fits all will certainly lead to housing appropriate for a few but mismatched for the many. It is important to remember that not all single parent families will share the same lifestyle, and that to favor by design any family type as dominant is to necessarily exclude others. However there can be a better "fit" between housing and families by examining differences as well as commonalities. Designers and planners need to recognize the importance of flexibility in designs as well as the importance of integrating work and home life for all types of families (Ahrentzen, 1989; Hayden, 1984; Soper, 1980; Wekerle, 1985). New architectural ideas alone cannot, however, solve the problem of the isolation of the laborer in the home (Hayden, 1980). Architects and designers can and have recognized the futility of the single family detached house, each with its own consumptive equipment, as something that does a disservice to many, indeed, most, American families. These designers have envisioned new housing forms better suited to the variety of American families. Overcoming more than a century of propaganda promoting the single family detached house will be difficult, but as more American families find housing environments unrealistic to their lifestyles and economic realities, new paradigms of the home will develop. Some of these new ideas are already

appearing in the literature; those that discuss the specific needs of women and single parent families will be discussed here.

Three housing projects designed especially for single parent families have been selected for analysis and comparison to single family detached houses. Each project and house have been matched for city, approximate square footage and number of bedrooms. The projects to be analyzed are Warren Village, from Denver, Colorado; Dayton Court, from St. Paul, Minnesota; and a prototype plan from the Women's Development Corporation of Providence, Rhode Island.

Warren Village. Warren Village is the first and currently the largest, housing development for single parent families in the United States (Franck & Ahrentzen, 1989). The project was completed in two phases, the first, 96 units, completed in 1974, and the second, 106 units, was completed in 1984. The development is operated as a non-profit organization. In order to meet the eligibility requirement of Warren Village, a prospective tenant must be a single household head of at least eighteen years of age, have no children over eleven years of age at the time of enrollment, have not more than four children, and have some source of income (this is usually a government subsidy) (Franck & Ahrentzen, 1989). The development offers on-site child care for children from age six weeks to twelve years. There are also on-site counseling, job training and educational services offered.

The housing units at Warren Village range from one to three bedrooms and are from 520 to 965 square feet in size. Figure 4 illustrates the plan of the typical two and three bedroom units.

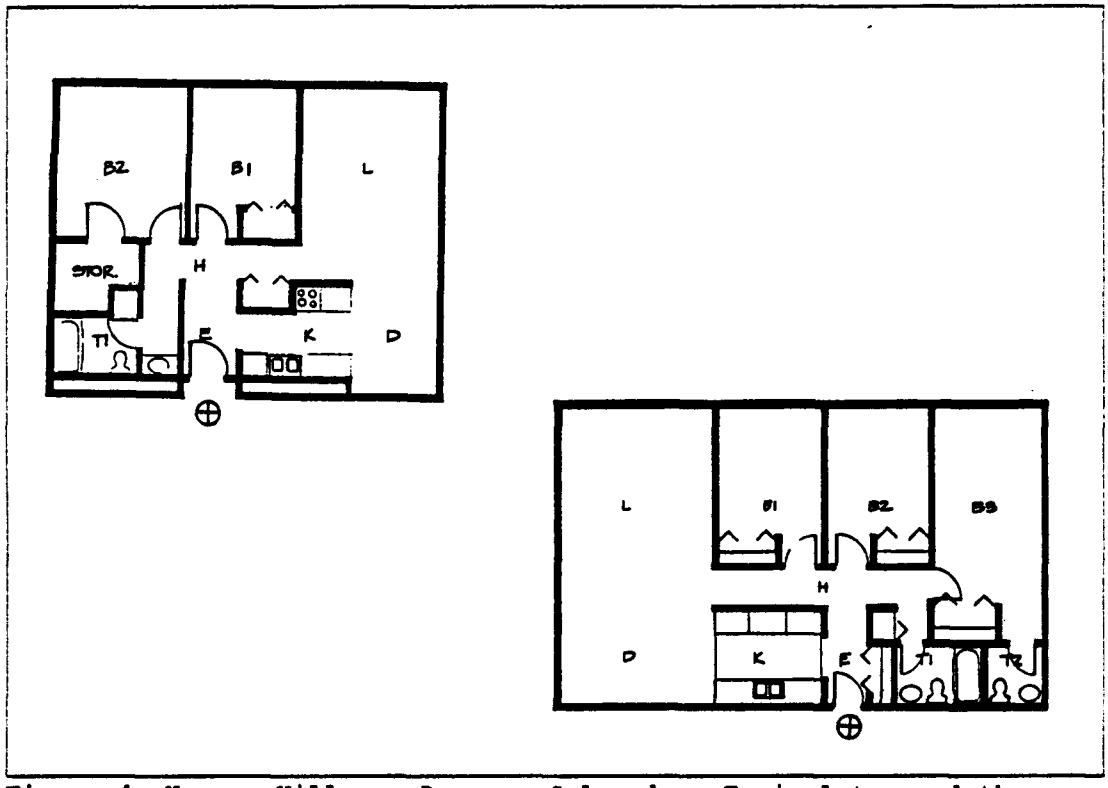


Figure 4. Warren Village, Denver, Colorado. Typical two and three bedroom units.

Dayton Court. Dayton Court, in St. Paul, Minnesota is a project that grew out of a design competition for the "New American Home" (Leavitt, 1989). The competition called for six prototypical units of infill housing designed especially for non-traditional households. The winning design utilized a three story row house concept due partly to site constraints and in part to a desire to allow direct outdoor access to every unit. The final design consists of six three bedroom units of 1,425 square feet each, four two bedroom units of 1,175 square feet each, two one bedroom units, and two duplexes. The two and three bedroom units, illustrated in Figure 5, will be the only units to be analyzed. Site constraints caused the original idea of an on-site child care center to be omitted and also led to the removal of

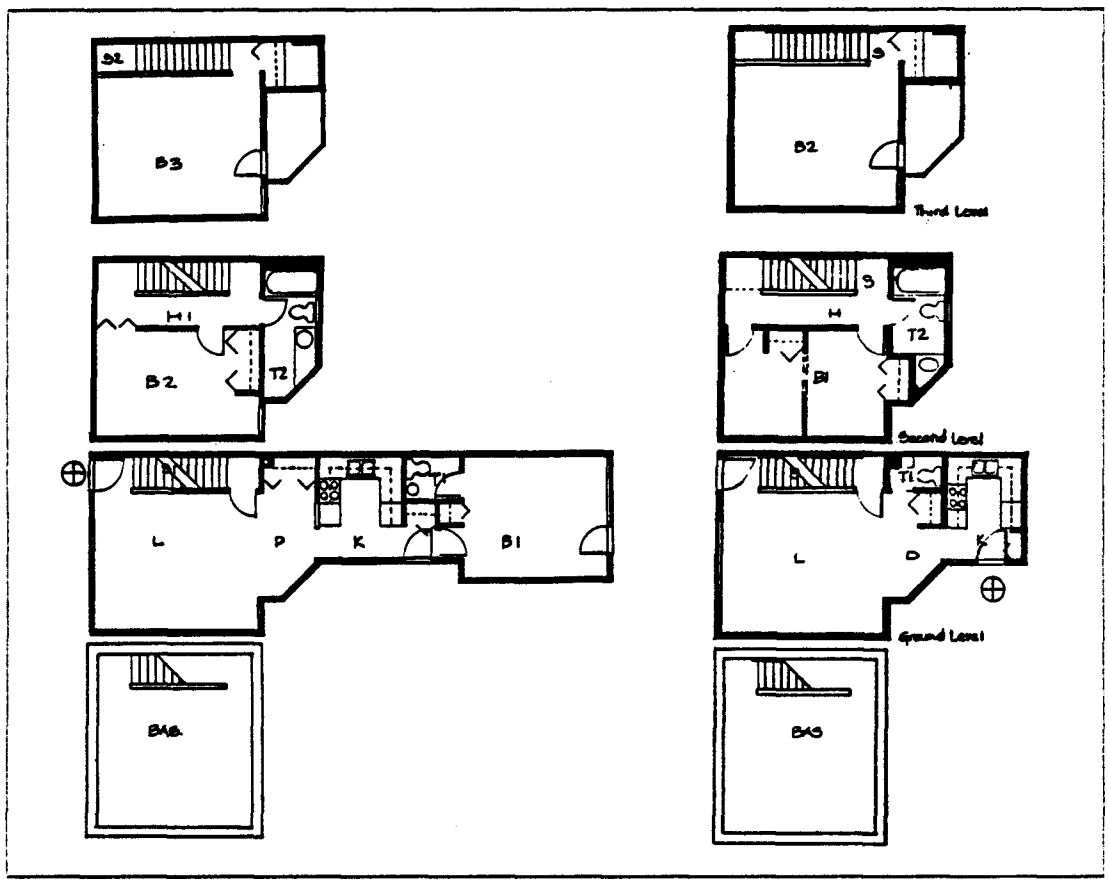


Figure 5. Dayton Court. Typical two and three bedroom units.

explicit spaces for home work spaces (Leavitt, 1989). Frustrations cited by the designer of the project include: the difficulty of obtaining recognition for designs of innovative housing, and the expensive nature of such innovation, to the extent that the population for whom the design is intended is unable to afford it (Leavitt, 1989). A conclusion drawn from the competition was that, despite an active exchange of ideas and a supportive community environment, the needs of lower income single parents cannot be met by the private market. The changes in the original design required by the site and the market will allow Dayton Court to be a test of how well this

housing meets the needs of mid to upper income single parents rather than low income single parents.

Women's Development Corporation. The housing designed for single parent families in Providence, Rhode Island is represented by a prototype unit designed by the Women's Development Corporation. Most of the housing for single parents produced by the Women's Development Corporation involves the rehabilitation of existing structures (Franck & Ahrentzen, 1989). Ten such units have been scattered about the city. The design for the units were developed through neighborhood workshops with single parents. Most of the units are three bedrooms

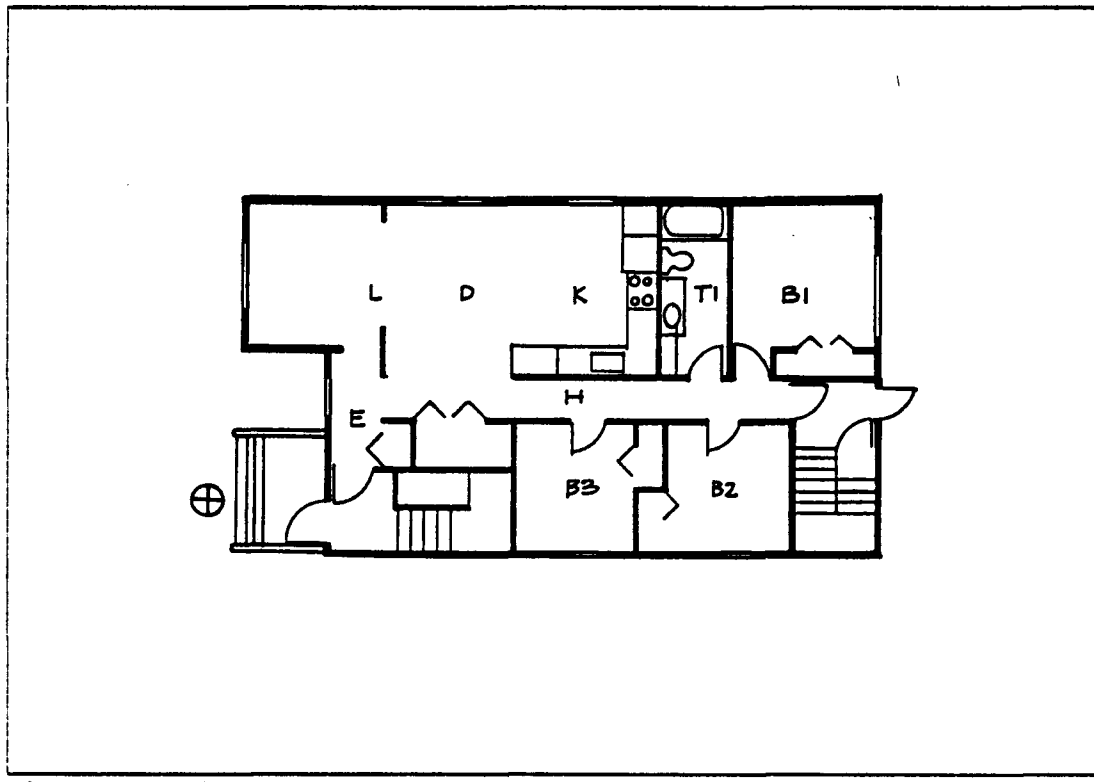


Figure 6. Single parent family dwelling, Women's Development Corporation, Providence, RI.

and connect the living, dining, and kitchen areas so a variety of activities could take place at once. The prototypical plan is illustrated in Figure 6.

Observations on the Literature

Because an overwhelming amount of housing in the United States has been designed and constructed for an ideal family that does not match demographic realities, many families are housed in inadequate dwellings to suit their needs (Birch, 1985; Cook, 1988; Franck & Ahrentzen, 1989; Hayden, 1981 & 1984; Rothblatt, Garr & Sprague, 1978; Wekerle, 1985). The separation of public and private life and the association of women exclusively with the home have made the single family detached house and the suburban neighborhood in which it is found difficult for family forms other than the traditional nuclear family. This is especially true for the single parent family (Birch, 1985, Franck & Ahrentzen, 1989, Leavitt, 1985).

The problems faced by single parent families in their housing environments go beyond spatial mismatches into deeper social issues of class and gender (Franck, 1985; Hayden, 1981; McDowell, 1983). Gender is considered by Franck (1985) to be "...the division...between behaviors and attitudes society deems appropriate for males and females, respectively" (p. 144). Gender has traditionally been applied as a transformation of observable biological differences into expected social differences (Franck, 1985). The construction of the built environment, particularly housing, and especially single family detached housing supports a gender division of space that restricts and identifies women with the home and men with public life (McDowell,

1983). These gender divisions are furthered by land use policies segregating residential and wage work areas (McDowell, 1983). The continuation of the mystique of the home as haven, rather than as support and service system, as well as the idea of the home historically as an object of conspicuous consumption and status (Loyd, 1982), all enhance the gender division of space and place more stresses on the single parent family. The dual roles of provider and homemaker conflict based on the separation of work and home life enforced by many zoning ordinances. However, single parents feel compelled to fulfill all the roles expected of them despite the conflict and despite the acknowledgement of the lack of the financial means and emotional support to do this (D'Ercole, 1988). The suburban built environment as currently constructed, facilitates only one female role, that of homemaker and mother (Fava, 1981), not only due to its physical nature, but also due to the cultural and social associations of the single family detached home.

Spatial arrangements reinforce societal constraints (Cook, 1988). The societal constraints of American family life have in the past called for the idealized household of wage earning father and homemaking mother; the spatial arrangement for this family type is the suburban single family detached house. However, it is important to recognize and continue to recognize all changes and permutations in family structure and to understand the role of housing in serving these families. No longer can a single prescription of family life be accepted. It is important to remain sensitive to the issues of individual families while attempting to generalize solutions to major

problems of spatial inequalities. The value of home and family is one that can be supported without the ideal of the suburban single family house, the traditional nuclear family, or the gender division of space (Hayden, 1984). Methods need to be developed to provide real housing choices for women and single parent families, with a focus on the political and economic realities that frame those choices (Hayden, 1981).

Methods of Comparing Housing Form

Introduction

This section will discuss two methods to address the spatial arrangements of the single family detached house in comparison to the housing being proposed for the single parent family: gamma analysis and annotated analysis.

Gamma Analysis

Hillier and Hanson (1984) cite several studies revealing the social nature of space. These studies however examine the social aspects of a culture first and then explain the spatial nature in relation to these social aspects. In The Social Logic of Space, Hillier and Hanson (1984) seek to reverse this spatial examination by looking first at the spatial form. The method they develop attempts to build a conceptual model of space within which social content can be investigated. The method develops an analysis of spatial pattern with an emphasis on the relation between the local spatial relations and the global patterns. It establishes a descriptive theory of how spatial pattern can, and does, carry social information and content (Hillier & Hanson, 1984). A theory is developed of how and why

different forms of social reproduction require and find an embodiment in different spatial arrangements. A model of this theory is presented in Figure 7. This model describes how idealogy controls the form of the built environment. The more global-to-local the emphasis (i.e., the more societal norms (global) affect private personal space (local), the more the space will be controlled. In this way an abstract set of social categories becomes manifested in a physical way in the built environment (Hillier & Hanson, 1984).

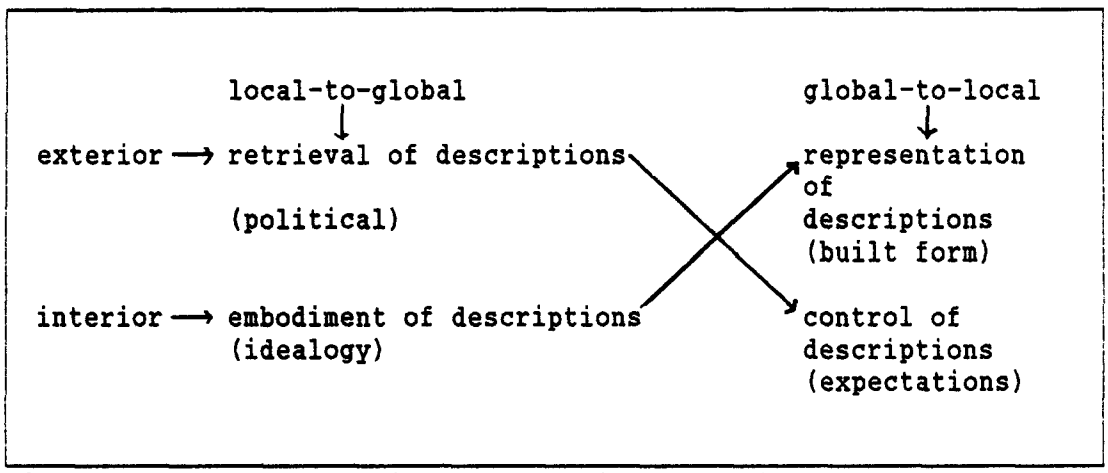


Figure 7. Model of Spatial Reproduction of Social Idealogy. Adapted from The Social Logic of Space. (p.260) by Hillier & Hanson, 1984, New York: Cambridge University Press.

The method of Hillier and Hanson (1984) offers a graphic representation of space to describe in a structured and quantitative way the construction of space. The object of the analysis is not to offer another description of the space but to show how differences in spaces are generated by, and embodied in, their form, structure, and different social purposes. The social purpose of housing for nuclear families and single parent families has been discussed above. The hypothesis of this research is that societal gender stereotypes have

an affect on the shape and space of housing. The goal, through the application of the techniques of analysis, is to attempt to uncover evidence that points to hypothesis.

Markus (1987) applied gamma analysis to several building types in a study of buildings and the texts used to describe them. Markus (1987) contends that buildings are structured socially through power structures, ideas, practices, and beliefs. It was found that buildings can have an explicit function of separating people or objects into classes (Markus, 1987). In residential buildings this is manifested in the division between men and women (McDowell, 1983).

To see how residential buildings divide men and women, and in extrapolation adversely affect single parent families, it is necessary to see the ways in which buildings carry social meanings. Examining spatial relationships in a social context, which is gamma analysis, allows this (Hillier & Hanson, 1984). The sequence of rooms, the number of entrances and exits, the number of paths possible to reach a space, and the depth of each room within a building all create spatial experiences which relate to social functions (Markus, 1987). Markus (1987) contends that classes of forms of equivalent status will occur at the same depth in a building, and that therefore a hierarchy of status can be developed within a building beginning with the most accessible, integrated spaces and resulting in the least accessible, most segregated spaces. The method of gamma analysis is illustrated by example in Chapter III and is further explained in Appendix E.

Annotated Analysis

In addition to gamma analysis, a qualitative analysis will be performed for each family's housing. This analysis is intended to be compared to the gamma analysis and will show how well each house is designed in terms of the needs of the specific family type for which it was intended. This analysis is based on the examination of the literature of spatial arrangements for the two family types as presented earlier in this chapter (see also Appendices A and C). A check list has been developed for the housing for each family type (Appendices B and D) and each floor plan will be annotated according to the appropriate check list. The checklists described in Appendices B & D will be expanded into an annotated checklist that will accompany each annotated plan. Annotated analysis is more fully described through example in Chapter III.

The Methods in Comparison: An Overview

Each of the analyses, gamma analysis and annotated analysis, provides a glimpse into a different but related aspect of housing. The annotated analysis is being used to determine the "fit" of the housing to the family type, and the gamma analysis is being used to determine the relative integratedness of the different rooms in each house. Essentially, the annotated analysis will "test" the plan against the family type for which it is intended, and the gamma analysis will "test" the plans for each family type against each other in order to establish if any differences are apparent due to social patterning. The methods will be used in Chapter III to develop a

means of ranking rooms according to their degree of integration in a house (see also Appendices A and C).

CHAPTER III

METHODOLOGY

Introduction

The intent of this research is to determine if there is a difference in room arrangement between the housing for nuclear families, the single family detached house, and housing purportedly designed for single parent families. Plans of the housing for the respective families were obtained from two sources; 1) the research literature and housing developments provided the plans for the single parent family dwellings, and 2) the plans of single family detached houses were obtained from Century-21 real estate offices. The following chapter will describe and illustrate the methods of analysis to be applied to the plans in this research. An example of the methods of gamma analysis and annotated analysis will be provided here as part of the description of the analysis techniques.

Description of Techniques of Analysis

Gamma Analysis Described

Gamma analysis suggests a method of examining rooms in a building in a quantified manner and allows for a social analysis of those spaces. It involves examining the syntax of interior spaces. The method allows for an analysis and comparison of buildings in terms of how categories of space are related and arranged, and how the building works as an interface between inhabitants and visitors. The building can be described as having two basic properties: the boundary of the house, the perimeter that separates the house from the exterior world; and the interior permeability, the juxtaposition that

ensures that every part of the house is accessible from every other part. Gamma analysis is the analysis of these two basic spatial relations and controls.

Gamma Maps

Gamma analysis transforms the floor plan into gamma maps (Hillier & Hanson, 1984), with every interior space represented as a circle, and its relations of permeability represented by a line. In other words each room or space becomes a circle and every entrance and exit or connection of that room to another or to the outside of the building becomes a line.

The carrier for the gamma map is the space that is to be considered as the point of reference. It is the abstract space that defines the location of the object of analysis. The carrier for the entire building is the space outside of the building. The carrier is redefined for computation purposes as each interior space is analyzed and as each interior space becomes the object of analysis. The carrier allows a point of reference to exist for each interior space as well as for the entire building. The carrier is represented on a gamma map as a circle with a cross inside. It is used to help determine the measure of integration or segregation for the interior spaces as well as for the building as a whole. Figure 8 is an example of a gamma map for a single family detached house. For a full description of the principles of gamma analysis and a step by step creation of a gamma map please see Appendix E.

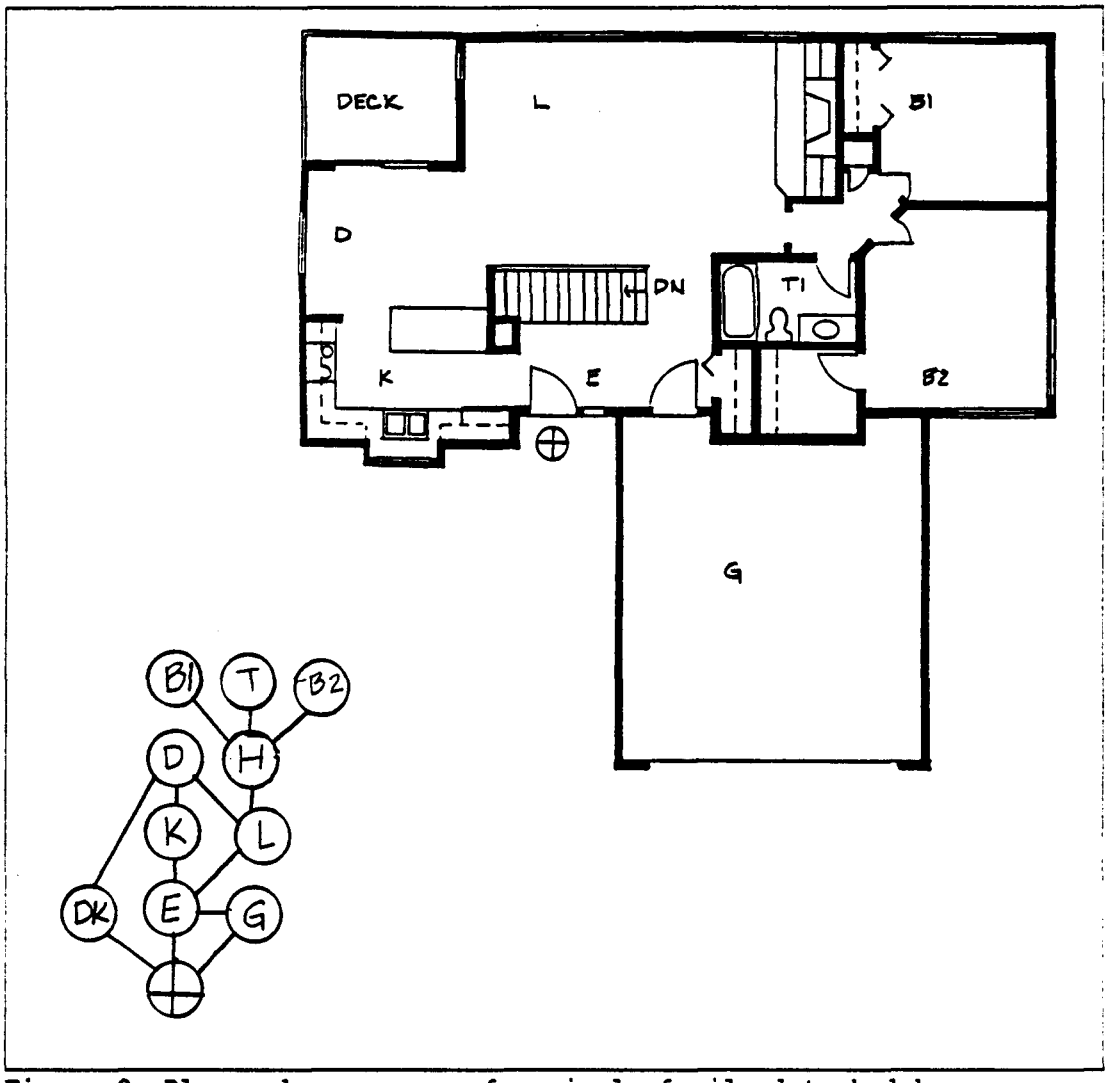


Figure 8. Plan and gamma map of a single family detached house.

Justified Gamma Maps

A justified gamma map is constructed and defined by assigning every space a depth value according to the distance it is from the carrier. Distance is not measured in feet and inches but rather in the minimum number of spaces from the carrier. All spaces that are the same depth from the carrier are lined up horizontally above the carrier, with lines representing the direct connections to other spaces drawn in as needed. Justified gamma maps allow for the

relations of the spaces to each other to become easier to see than in the plan itself. These maps also permit quantitative measurement of these properties. The most important measurement in this analysis will be relative asymmetry (RA), measuring the degree of integration of each space in the building. The relative asymmetry compares how deep a space is from a particular point. Relative asymmetry is found in the following manner:

$$RA = \frac{2(MD - 1)}{k-2}$$

where MD = mean depth of the space, found by adding all of the depth measurements for the building together and dividing by the number of spaces minus one (the space being analyzed), and k = the number of spaces in the system. Relative asymmetry is the measure of integration of the space. The mean relative asymmetry measures the integration of the entire system. Relative asymmetry (RA) values can range from zero to one with low RA values indicating a high degree of integration, and high RA values indicating a low degree of integration or a high degree of segregation of spaces. The relative asymmetry (RA) values will serve two purposes in this research. The first will be to quantify the relations of the spaces under examination in order to provide a means of comparison between the housing for the two family types. A comparison of the values is intended to illustrate the degree of integration and/or segregation the housing types have relative to each other. The second purpose of the RA values is to provide a means of ranking the rooms for each housing type by order of integration. This ranking will provide a hierarchy of integration

that can be compared across housing types. In addition the order will be compared to an expected order of rooms based on an examination of the literature. The literature review presented in Chapter II led to the expected relative asymmetry (RA) rankings, this review is repeated in Appendices A and C for each housing type along with the predicted RA values. For the small sample size presented here (5 pairs of housing) the ranking comparison may have the most validity. By presenting the rankings of the rooms by integration for each housing type, the pattern of the house becomes more clear. The pattern of the rooms can be discussed in light of annotated analysis, free from numerical comparison. In essence a quantitative analysis (gamma analysis) will be performed in order to examine spatial arrangements qualitatively (annotated analysis).

Ringiness and Space Link Ratio

Relative ringiness measures the number of alternate routes available between spaces in a building. Rings occur when the number of connections between the number of spaces (k) is (k) or greater (Hillier & Hanson, 1984). The space link ratio (Hillier, Hanson, & Graham, 1987) quantifies the ringiness measure. It is measured on a scale from 1 to 2 and is determined by dividing the number of connections between rooms plus one by the number of spaces (rooms):

$$\frac{\text{number of connections between rooms} + 1}{\text{number of rooms}} = \text{Space Link Ratio}$$

Examining the ringiness of a building through the space link ratio provides a measure of the control of the building. In general, buildings that have a higher space link ratio value will be more

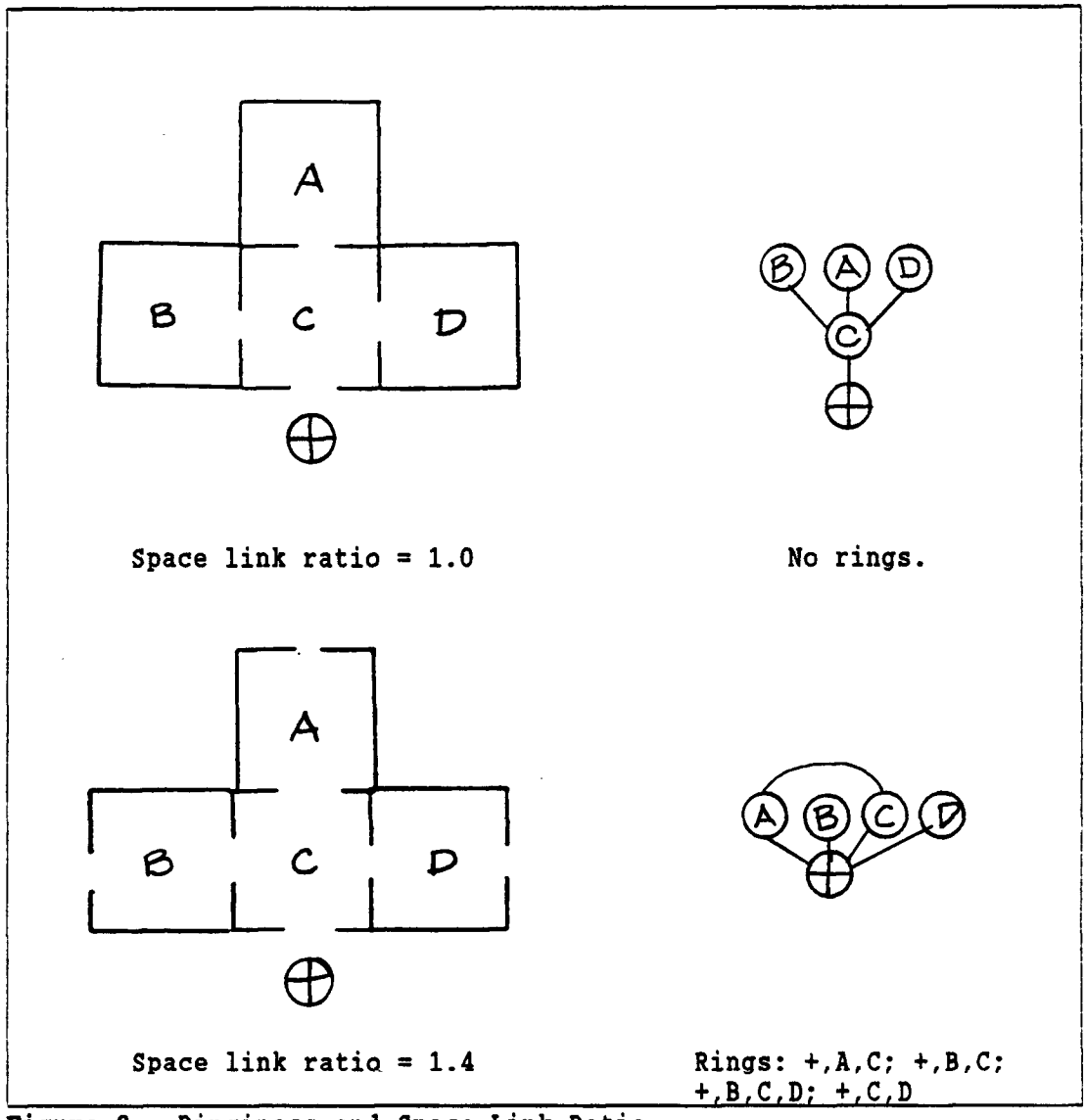
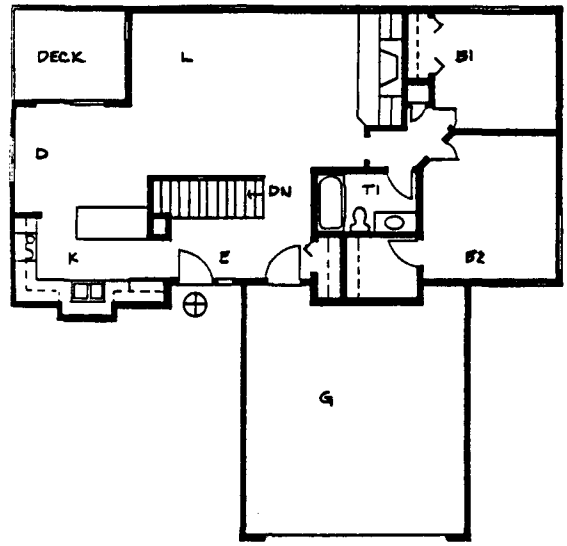


Figure 9. Ringiness and Space Link Ratio.

"ringy", or have more options for routes between spaces than those buildings that have a smaller space link ratio value. A space with no rings will have a space link ratio of one. Figure 9 illustrates both the idea of ringiness and the space link ratio through the analysis of two hypothetical plans. The more distributed the system, or the greater the space link ratio, the more diffused will be the spatial control. The less distributed, that is the lower the value of the

space link ratio, the more centralized will be the spatial control. Figure 10 illustrates the space link ratio and rings of the single family detached house of Figure 8. The main living areas of the house are tied together by a ring of connections, while the sleeping areas are linked linearly.



Space link ratio = 1.27

Rings:
+ DK K D E
+ E G
+ G E K D DK
+ G E L D DK
D K E L

Figure 10. Rings and space link ratio of a single family detached house.

Example of Gamma Analysis Technique

The basic proposition of gamma analysis is that buildings transmit social information through their layout and floor plan, both through variations in these and through the examination of these from different constituent spaces. Spatial labels are important in gamma analysis, what a room is called and how it is generally used become important indicators when examining the relative asymmetry of the

space. Figure 11[i] illustrates the gamma analysis technique for the single family detached house of Figure 8. The plan and gamma map are provided for reference. The relative asymmetry (RA) table is designed to demonstrate the generation of the relative asymmetry values for each interior space as well as the building as a whole (see also Appendix E). The integration measure for the entire building (how well the interior integrates with the exterior) is the RA value obtained by using the outside of the building as the carrier or point of reference. As each interior space is analyzed it becomes, in turn, the carrier and the depth values change accordingly, as indicated in Figure 11. The RA values obtained indicate the integration or segregation of each space from the rest of the building. In addition to the relative asymmetry (RA) values (Figure 11), a ranking of major living areas by RA value, as determined in Appendices A and C, is presented in Figure 12. The ranking of spaces by relative asymmetry value involves comparing the two methods of analysis to be used and will be described later in this chapter.

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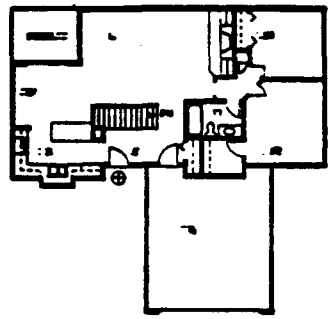
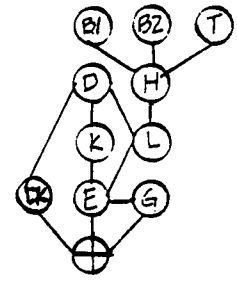
[i] Unless otherwise noted the following definitions hold for figures presented here: + = carrier, E = entry, G = garage, DK = deck, K = kitchen, L = living room, D = dining room, B = bedroom, T = toilet (bathroom), S = stair, H = hall, UN = unfinished.





RELATIVE ASYMMETRY VALUES

SPACE	+	E	G	DK	K	L	D	H	B1	T	B2	MD	RA
+	0	1	1	1	2	2	3	3	4	4	4	2.5	.333
E	1	0	1	2	1	1	2	2	3	3	3	1.9	.200
G	1	1	0	2	2	2	3	3	4	4	4	2.6	.356
DK	1	2	2	0	2	2	1	3	4	4	4	2.5	.333
K	2	1	2	2	0	2	1	3	4	4	4	2.5	.333
L	2	1	2	2	2	0	1	1	2	2	2	1.7	.156
D	2	2	3	1	1	1	0	2	3	3	3	2.1	.244
H	3	2	3	3	3	1	2	0	1	1	1	2.0	.222
B1	4	3	4	4	4	2	3	1	0	2	2	2.9	.422
T	4	3	4	4	4	2	3	1	2	0	2	2.9	.422
B2	4	3	4	4	4	2	3	1	2	2	0	2.9	.422
												MEAN:	.283

k=11

Space link ratio = 1.27

Figure 11. Example of gamma analysis using a single family detached house.

Room Ranking by actual versus predicted relative asymmetry values

Actual (Computed) Values		Predicted Values
Room	Value	Value
Living room	.156	.125 to .250
Dining room	.244	.200 to .500
Kitchen	.333	.300 to .600
Bedroom/Bath	.422	> .400

Range of RA values .266

Figure 12. Ranking of rooms by relative asymmetry values for a single family detached house.

Findings. Figure 11 illustrates the relative asymmetry values for the example plan and Figure 8 illustrates the gamma map for the example plan. Gamma analysis allows the relations between the rooms to be abstracted and easily seen. The main living areas of the house, for example, are tied together by a ring of connections (Figure 10). The sleeping areas of the house are somewhat segregated from the core of the house (Figure 10). The sleeping areas are not on any rings although they are linked by a hallway to the rest of the house. The relative asymmetry (RA) values (Figure 11) quantify these observations. The spaces with lower RA values lie on the ring while the spaces not on the ring have higher RA values. These values indicate the degree of integration the rooms have (lower RA values indicating a higher degree of integration). The ranking of the rooms, based on the RA values, match the ranking expected (Figure 12).

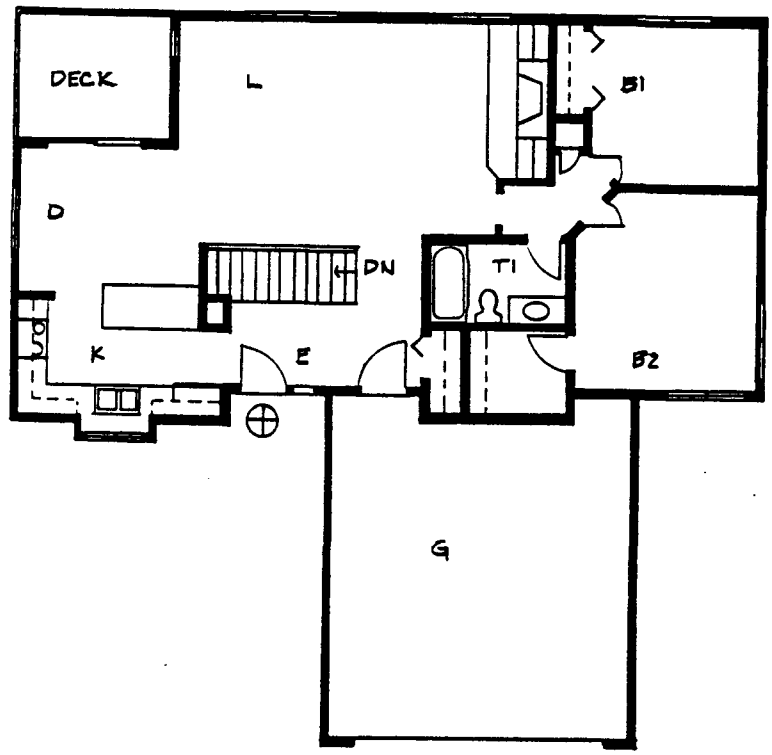
Although this example presents a plan in isolation and the research to be performed here will be a comparison, the social aspects

of the space can be discussed. This example of a single family detached house exhibits an expected hierarchy of rooms for the dwelling type. The societal norms, in this case, the expected roles of men and women are reflected in the room arrangement. Research has shown that despite the increase of women in the work force (Gerson, 1983) little household help is supplied by other family members (Berk, 1985). This aspect of gender division is manifested in the plan by a lack of direct connection between the living room (a place of rest) and the kitchen (a place of work). Even visual access is limited. The layout of the rooms, in this example, serves to separate men and women in the home. The most accessible major rooms in this example are the living and dining rooms (Figure 8) which are both relaxation and entertainment oriented. The kitchen falls where expected on the integration scale, between the overtly public and the overtly private areas of the house. The bedrooms and baths are the most segregated, as would be expected by their function.

Annotated Analysis Described

In addition to gamma analysis, a qualitative analysis will be performed for each family's housing. Annotated analysis was briefly described in Chapter II as a method to test the fit of housing for a given family type. A check list has been developed for the housing for each family type based on the literature review in Chapter II. Each floor plan to be examined will be annotated according to the appropriate check list. The checklist for analyzing the plans and the spatial descriptions from the literature upon which they are based are presented in Appendices A through D. The checklists described in

Appendices B and D will be expanded into an annotated checklist that will accompany each annotated plan, as will be shown in the following example. Each of the items on the checklist will be noted as being met or not met for the plan in question by the presence or absence of an asterisk, respectively. The plans will then be "scored" by room based on how it matches the annotated checklist and the room scores will be averaged to arrive at a score for the building. The scale will be zero to one; a score of one will indicate that every item on the list was met, a score of zero will indicate that none of the items on the list were met. This will be considered an indication of how well the plan matches the needs of the family type in question. The following figure (Figure 13) is an example of an annotated analysis of a plan for the same single family detached house that was seen in Figures 8 and 11. The annotated checklist of this plan follows as text.



Annotated checklist score

Room	Score	Total House Score
E Entry	.333	.676
H Hall	1.000	
L Living room	.800	
F Family room	0.000	
D Dining room	1.000	
K Kitchen	.200	
Ba Bath	.750	
B Bedroom	1.000	
O Outdoor space	1.000	

Figure 13. Annotated analysis of a single family detached house.

Annotated Checklist

Annotated Checklist for the Single Family Detached House Example
* indicates item is met by the plan.
A score of one is optimal fit.

Entry
E-1 The entry is a focal point.
* E-2 The entry leads to circulation to living, sleeping and service areas.
E-3 The entry offers no direct view into any room.
Score 0.333

Hall
* H-1 The hall provides access to all areas.
Score 1.000

Living room
* L-1 Traffic from the front door does not directly enter the living room.
* L-2 The living room is not affected by street noise.
* L-3 The bathroom is out of sight and sound from living room.
* L-4 The living room connects to the dining room.
L-5 The living room is not used as a pathway.
Score 0.800

Family room
F-1 The family room should be away from the sleeping areas.
F-2 The family room is separate from but near to the living room.
F-3 The family room is near the kitchen.
F-4 The family room is not used as a pathway.
There is no family room in this particular plan.
Score 0.000

Dining room
* D-1 The dining room is adjacent to the living area.
* D-2 The dining room is adjacent to the kitchen.
* D-3 The dining room is between the living room and the kitchen.
Score 1.000

Kitchen
K-1 The kitchen is near the dining room but able to be closed off from it.
K-2 The indoor play area is visible from kitchen.
K-3 The kitchen is near the service and garage areas.
K-4 The kitchen is near to a bathroom.
* K-5 The kitchen is close to outdoor access.
Score 0.200

Bathroom

* Ba-1 the bathroom is near the bedrooms.
* Ba-2 Bathroom noises are insulated from other spaces.
    Ba-3 There are at least one and one half baths per house.
* Ba-4 There is no view into an open bathroom door.
Score 0.750

Bedroom
* B-1 The bedroom opens into a hall.
* B-2 The bedroom is large enough to accommodate living spaces.
* B-3 The bedroom is in a quiet area.
* B-4 The bedroom is private.
* B-5 The bedroom is near a bathroom.
* B-6 The bedroom is away from major living areas.
Score 1.000

Outdoor space
* O-1 The primary outdoor spaces are at the back of the house.
* O-2 There is easy access to the house.
* O-3 The outdoor areas are secluded from the street.
Score 1.000

Total score = 0.676

Findings

The above annotated checklist allows those aspects of a plan that help to describe its "fit" to the needs of a family type to be more easily seen. For the example plan, using this checklist indicates that some spaces in the house are very well suited to a nuclear family and other spaces are not. The rooms that scored high on the scale, close to or equal to one, are the living room, the dining room, the bedrooms, bathroom, and the outdoor space. The kitchen, with a score of 0.200, does not seem well suited for a nuclear family, mainly due to the lack of access to other service areas of the house.

The Methods in Comparison: An Example

An example of the analysis to be performed has been demonstrated here (Figures 8, 11 and 13) using a plan of a single family detached

house. The gamma analysis was conducted and described, and the annotated analysis was conducted using the single family house checklist (Appendix B). The annotated checklist for this example was presented above.

The two methods have been combined to predict a ranking of rooms that will be used during the gamma analysis phase of the research. This ranking was developed by examining the descriptions of the rooms of both housing types and assigning them a predicted relative asymmetry score based on the level of integration expected. The predicted room ranking for a single family detached house versus the computed relative asymmetry values was presented in Figure 12 for the example plan. This ranking is based on placing the rooms in order from lowest (most integrated) to highest (most segregated) relative asymmetry value. Figure 14 illustrates the expected ranking for the housing for each family type to be studied here. It is expected that the range of relative asymmetry values will be greater for the single family detached house than for the housing for single parent families due to the effort to integrate work and home life that is so central to the design for single parent families. In order to truly determine expected relative asymmetry values an exhaustive study of each particular housing type would be required; since that has not been done here it is more important to examine the order of the rooms, the ranking, than the numbers associated with that ranking.

An Example

Throughout this Chapter the plan of a single family detached house has been used to illustrate the two analysis methods to be used

Predicted Relative Asymmetry Values and Room Ranking

Single Family Detached Housing

Room Ranking Values	Predicted Relative Asymmetry
Entry/ Circulation spaces	< .225
Family room	.125 to .250
Living room	.150 to .300
Dining room	.200 to .500
Outdoor space	.250 to .600
Kitchen	.300 to .600
Bedrooms/baths	> .400

Single Parent Family Housing

Room Ranking Values	Predicted Relative Asymmetry
Entry/ Circulation spaces	< .150
Living room	.150 to .300
Kitchen/ Dining room	.200 to .400
Outdoor space	.300 to .500
Bedrooms/Baths	> .350

Figure 14. Predicted relative asymmetry values and room ranking for single family detached housing and housing for single parent families.

in Chapter IV. Each method of analysis has been carried out on the plan and the finding of each briefly discussed. When the findings of the two methods are compared it is discovered that the plan in question (Figures 8-13) is moderately suited to the needs of the nuclear family for which it was designed. The gamma analysis revealed a house that meets the predicted room ranking and offers a more integrated plan than would be expected. The house is fairly ringy (space link ratio = 1.27) with the major living areas located on the rings. It is possible to explain the lack of fit of the house to the nuclear family as due to the house being more integrated than called for in the literature. Despite this the expected, "traditional" roles

of men and women are reflected in the floor plan of the house as discussed in the gamma analysis section of this chapter.

Statistical Analysis

As a part of the analysis to be presented in Chapter IV, a two-tailed t-test will be conducted on both the annotated analysis and gamma analysis results. This test will help to determine what, if any statistical differences exist between the housing for the two family types as portrayed through the analysis methods. The t-test was chosen as the method of statistical analysis for this study because of its robustness. The initial analysis revealed similar variances for both the gamma analysis data and the annotated analysis data. Normality will be assumed. The t-tests and the t-test results are presented in Appendix G.

Conclusion

This Chapter has illustrated the use of the analysis techniques for the plans to be discussed in this research. In the following chapter the plans for the single family detached houses and the housing for single parents will be compared to each other using these analysis methods. This analysis will hopefully allow a better understanding of the response of housing to social pressures.

CHAPTER IV

FINDINGS AND DISCUSSION

Introduction

The two methods discussed in Chapter III were applied to the housing units described in Chapter II. In this chapter the results of the analyses and a summary of the comparison of the housing types will be presented.

Sample Profile

The sample consists of single family detached houses and housing purportedly designed for single parent families from three cities in the United States: St. Paul, MN, Denver, CO, and Providence, RI. The dwelling units from each city were paired based on number of bedrooms and square footage. The fit of each plan to the intended family type was determined using the annotated analysis method; and the level of integration for each room in each plan was determined using the gamma analysis method. The results of these analyses will be presented as follows: first a discussion of the findings of the analyses of each plan for each family type will be presented, then a summary of the findings of each of the groups of housing. Finally, a comparison of the two groups of housing will be presented to determine if there are differences between them.

For the comparison to be conducted here only the major living spaces will be considered. The transition spaces of the houses, the hallways and stairs are included (and will be presented in the tables) in the calculations but are removed from the analysis for the comparisons. What will be of concern here is how the main areas of

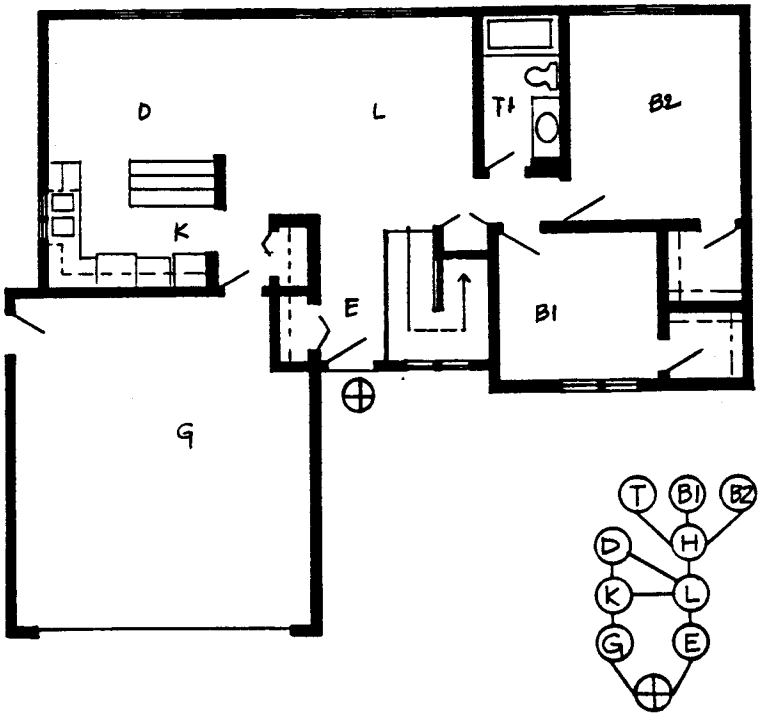
the house: the living room, dining room, bedroom, bathroom, kitchen, and carrier compare to each other for the two housing types.

Single Family Detached Houses

The results of each house will be presented individually. The cumulation will be a summary of all of the single family detached houses under analysis.

St. Paul: Two Bedroom Single Family Detached House

Figure 15 illustrates the floor plan, relative asymmetry table, gamma map and annotated analysis score for the two bedroom single family detached house in St. Paul. The annotated checklist for this plan appears in Appendix F.



MINNESOTA TWO BEDROOM SINGLE FAMILY DETACHED HOUSE

	•	E	G	L	F	D	K	B1	B2	B3	T1	T2	H1	H2	S1	S2	U1	MD	RA
•	0	1	1	2		3	3	4	4		4		3					2.78	0.444
E	1	0	2	1		2	2	3	3		3		2					2.11	0.278
G	1	2	0	2		2	1	4	4		4		3					2.56	0.389
L	2	1	2	0		1	1	2	2		2		1					1.56	0.139
F																			
D	3	2	2	1		0	1	3	3		3		2					2.22	0.306
K	2	2	1	1		1	0	3	3		3		2					2.00	0.250
B1	4	3	4	2		3	3	0	2		2		1					2.67	0.417
B2	4	3	4	2		3	3	2	0		2		1					2.67	0.417
B3																			
T1	4	3	4	2		3	3	2	2		0		1					2.67	0.417
T2																			
H1	3	2	3	1		2	2	1	1		1		0					1.78	0.194
H2																			
S1																			
S2																			
U1																			
MEAN RELATIVE ASYMMETRY VALUE FOR ALL SPACES																			0.325

Mean RA score (main living spaces only) = 0.341
Annotated analysis score = 0.540
Space link ratio = 1.20
Square footage = 987

Figure 15. Summary findings for a two bedroom single family detached house in St. Paul, MN.

Gamma analysis results. The house meets some predicted relative asymmetry values and fails to meets others. A listing of the computed relative asymmetry values against the predicted values for the main living spaces only appears in Figure 16.

Room	Computed RA Values	Predicted RA Values	Result
Living	.139	.150 to .300	more integrated
Kitchen	.250	.300 to .600	more integrated
Dining	.306	.200 to .500	meets prediction
Bedrooms	.417	> .400	meets prediction
Bathrooms	.417	> .400	meets prediction
Carrier	.444	.250 to .600	meets prediction

Figure 16. Computed versus predicted relative asymmetry values for a two bedroom single family detached house in St. Paul, MN.

The living room and kitchen are both more integrated than expected. The other major living spaces all fall within the predicted range of relative asymmetry values. The range of relative asymmetry values run from a low (most integrated) of 0.139 (living room) to a high (least integrated) of 0.444 (carrier), with a range of 0.305. This value will be discussed in relation to the other single family detached house plans later in this chapter. The mean relative asymmetry value for the main living areas of this plan is 0.341, indicating a fairly well integrated plan.

Annotated analysis results. The house meets 18 of 27 suggestions for a single family detached house and has an annotated analysis score of 0.540. The annotated analysis seems to indicate a house that is well suited for the nuclear family in some areas (such

as the living room and dining room), and poorly suited in others (such as the kitchen, see Appendix F for the annotated checklist).

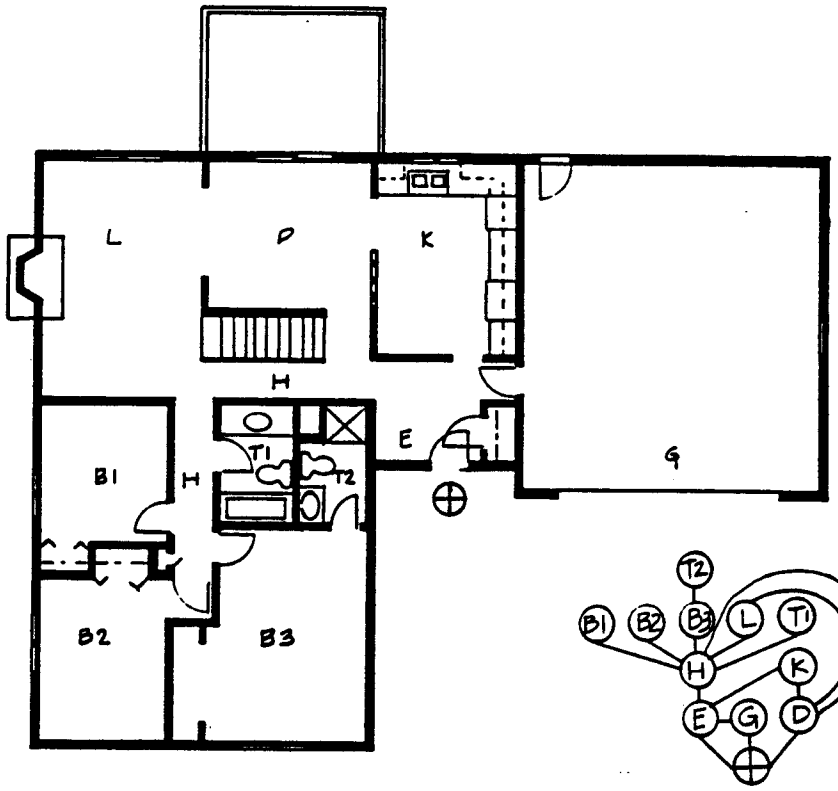
Summary and discussion. The house exceeds the predicted relative asymmetry in two rooms, the living room and the kitchen, and has a low relative asymmetry score (0.341) indicating an integrated plan. This could account for its weak fit to the claimed needs of the nuclear family as demonstrated in the annotated analysis (score = 0.540).

The plan contains at least three rings (space link ratio = 1.20), all involving core living areas (kitchen, living room, and dining room). Each of the rooms on a ring either meets or exceeds the predicted relative asymmetry values. The size of the house (987 square feet) could be a factor in its integrated nature. The rooms are open to each other which registers as more integrated in gamma analysis.

St. Paul: Three Bedroom Single Family Detached House

Figure 17 illustrates the floor plan, relative asymmetry table, gamma map and annotated analysis score for the two bedroom single family detached house in St. Paul. The annotated checklist for this plan appears in Appendix F.

Gamma analysis results. The house tends to be more integrated than called for by the predicted relative asymmetry values, as shown in Figure 18, with essentially all major living areas meeting or exceeding the predicted values. The integration values range from a low (most integrated) of 0.164 (dining) to a high (least integrated) of 0.400 (bathroom), a difference of 0.236. This value will be



MINNESOTA THREE BEDROOM SINGLE FAMILY DETACHED HOUSE																		
	✦	E	G	L	F	D	K	B1	B2	B3	T1	T2	H1	H2	S1	S2	U#	MD	RA
✦	0	1	1	3		1	2	3	3	3	3	4	2					2.36	0.273
E	1	0	1	2		1	1	2	2	2	2	3	1					1.64	0.127
G	1	1	0	3		1	2	3	3	3	3	4	2					2.36	0.273
L	2	2	3	0		1	2	2	2	2	2	3	1					2.00	0.200
F																			
D	1	2	2	2		0	1	2	2	2	2	3	1					1.82	0.164
K	2	1	2	3		1	0	3	3	3	3	4	2					2.45	0.291
B1	3	2	3	2		2	3	0	2	2	2	3	1					2.27	0.255
B2	3	2	3	2		2	3	2	0	2	2	3	1					2.27	0.255
B3	3	2	3	2		2	3	2	2	0	2	1	1					2.09	0.218
T1	3	2	3	2		2	3	2	2	2	0	3	1					2.27	0.255
T2	4	3	4	3		3	4	3	3	1	3	0	2					3.00	0.400
H1	2	1	2	1		1	2	1	1	1	1	2	0					1.36	0.073
H2																			
S1																			
S2																			
U#																			
MEAN RELATIVE ASYMMETRY VALUE FOR ALL SPACES																			0.232

Mean RA score (main living spaces only) = 0.257
Annotated analysis score = 0.790
Space link ratio = 1.25
Square footage = 1248

Figure 17. Summary findings for a three bedroom single family detached house in St. Paul, MN.

Room	Computed RA Values	Predicted RA Values	Result
Dining	.164	.300 to .600	more integrated
Living	.200	< .255	meets prediction
Bedroom	.218	> .400	more integrated
Bedroom	.255	> .400	more integrated
Carrier	.273	.250 to .600	meets prediction
Kitchen	.291	.300 to .600	more integrated
Bathroom	.400	> .400	more integrated

Figure 18. Computed versus predicted relative asymmetry values for a three bedroom single family detached house in St. Paul, MN.

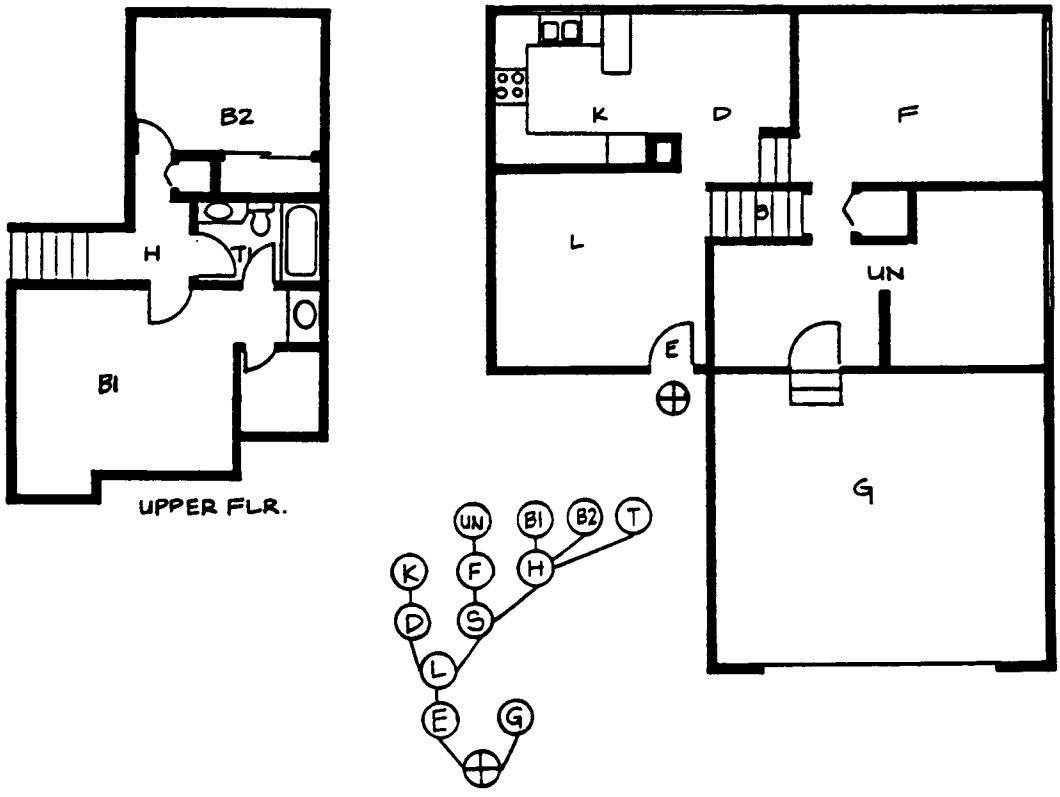
discussed in context with the other single family detached house plans later in this chapter. The mean relative asymmetry value for the main living areas of this plan is 0.257, indicating a well integrated plan.

Annotated analysis results. The house meets 25 of 30 suggestions for a single family detached house and has an annotated analysis score of 0.790. The major flaw in this plan, based on the annotated checklist, is the lack of a family room. The plan otherwise scores a very close fit to a nuclear family's needs. The annotated checklist for this plan can be found in Appendix F.

Summary and discussion. This plan is both seemingly well suited to a nuclear family (annotated analysis score = 0.790) and a seemingly well integrated (gamma analysis score = 0.257) plan spatially. The house contains at least five rings (space link ratio =1.25), most of which pass through the major living areas. The plan does present a hierarchy of integration despite being well integrated overall (mean relative asymmetry value = 0.257). The kitchen is more segregated than the bedrooms and is, in fact, more segregated than any other room except for one bathroom.

Denver: Two Bedroom Single Family Detached House

Figure 19 illustrates the floor plan, relative asymmetry table, gamma map and annotated analysis score for the two bedroom single family detached house in Denver. The annotated checklist for this plan appears in Appendix F.



DENVER TWO BEDROOM SINGLE FAMILY DETACHED HOUSE

	✦	E	G	L	F	S	K	B1	B2	B3	T1	T2	H1	H2	S1	S2	UN	MD	RA
✦	0	1	1	3	4	3	4	5	5		5		4		3		5	3.50	0.455
E	1	0	2	1	3	2	3	4	4		4		3		2		4	2.75	0.318
G	1	2	0	3	5	4	5	6	6		6		5		4		6	4.42	0.621
L	2	1	3	0	2	1	2	3	3		3		2		1		3	2.17	0.212
F	4	3	5	2	0	3	4	3	3		3		2		1		1	2.83	0.333
S	3	2	4	1	3	0	1	4	4		4		3		2		4	2.92	0.348
K	4	3	5	2	4	1	0	5	5		5		4		3		5	3.83	0.515
B1	5	4	6	3	3	4	5	0	2		2		1		2		4	3.42	0.439
B2	5	4	6	3	3	4	5	2	0		2		1		2		4	3.42	0.439
B3																			
T1	5	4	6	3	3	4	5	2	2		0		1		2		4	3.42	0.439
T2																			
H1	4	3	5	2	2	3	4	1	1		1		0		1		3	2.50	0.273
H2																			
S1	3	2	4	1	1	2	3	2	2		2		1		0		2	2.08	0.197
S2																			
UN	5	4	6	3	1	4	5	4	4		4		3		2		0	3.75	0.500
MEAN RELATIVE ASYMMETRY VALUE FOR ALL SPACES																			0.392

Mean RA (main living spaces only) = 0.407
Annotated analysis score = 0.460
Space link ratio = 1.00
Square footage = 1200

Figure 19. Summary findings for a two bedroom single family detached house in Denver, CO.

Gamma analysis results. Figure 20 illustrates the computed versus predicted relative asymmetry values for the main living areas of the two bedroom single family detached plan for Denver.

Room	Computed RA Values	Predicted RA Values	Result
Living	.212	.150 to .300	meets prediction
Family	.333	.125 to .250	less integrated
Dining	.348	.200 to .500	meets prediction
Bedroom	.439	> .400	meets prediction
Bath	.439	> .400	meets prediction
Carrier	.455	.250 to .600	meets prediction
Kitchen	.515	.300 to .600	meets prediction

Figure 20. Computed versus predicted relative asymmetry values for a two bedroom single family detached house in Denver, CO.

The range of relative asymmetry values for this plan begins at the most integrated space, the living room, with a value of 0.212, and ends at the most segregated space, the kitchen, with a value of 0.515; a range of 0.303. Overall the relative asymmetry values for the house are high with a mean of 0.407.

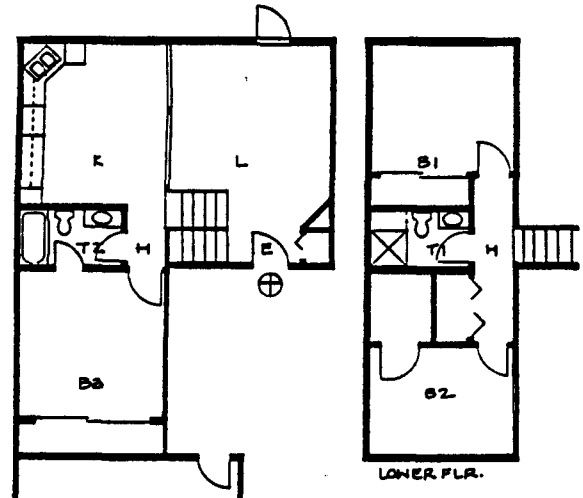
Annotated analysis results. The house meets only 15 of the 31 suggestions for a single family detached house as described on the annotated checklist and has an annotated analysis score of 0.460 (see also Appendix F). This plan does not appear to be well suited to a nuclear family.

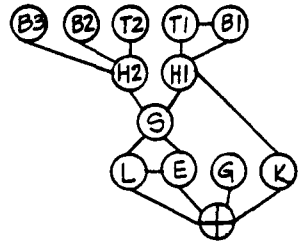
Summary and discussion. The plan of the two bedroom single family detached house in Denver appears to contain a series of highly segregated spaces (gamma analysis mean score = 0.407) as well as have a weak fit as a dwelling for a nuclear family (annotated analysis score = 0.460).

There are no rings in the plan (space link ratio = 1.00), the space is very linear. Because of the lack of rings, the entry and living room control access to the remainder of the house; no other rooms can be accessed without first passing through these areas.

Denver: Three Bedroom Single Family Detached House

Figure 21 illustrates the floor plan, relative asymmetry table, gamma map and annotated analysis score for the three bedroom single family detached house in Denver. The annotated checklist for this plan appears in Appendix F.





DENVER THREE BEDROOM SINGLE FAMILY DETACHED HOUSE

	+	S	G	L	F	D	K	B1	B2	B3	T1	T2	H1	H2	S1	S2	UN	MD	RA
+	0	1	1	1			1	3	4	4	3	4	2	3	2			2.42	0.258
S	1	0	2	1			3	3	3	3	3	3	2	2	1			2.25	0.227
G	1	2	0	2			2	4	4	4	4	4	3	4	3			3.08	0.379
L	1	1	2	0			2	3	3	3	3	3	2	2	1			2.17	0.212
F																			
D																			
K	1	2	2	2			0	3	4	4	2	4	1	3	2			2.42	0.258
B1	3	3	4	3			3	0	4	4	1	4	1	3	2			2.83	0.333
B2	4	3	5	3			4	4	0	2	4	2	3	1	2			3.08	0.379
B3	4	3	5	3			4	4	2	0	4	2	3	1	2			3.08	0.379
T1	3	3	4	3			3	1	4	4	0	4	1	3	2			2.83	0.333
T2	4	3	5	3			4	4	2	1	4	0	3	1	2			2.92	0.348
S1	2	2	3	2			1	1	3	3	1	3	0	2	1			2.00	0.182
S2	3	2	4	2			4	3	1	1	3	1	2	0	1			2.25	0.227
S1	2	1	3	1			2	2	2	2	2	2	1	1	0			1.75	0.136
S2																			
UN																			
MEAN RELATIVE ASYMMETRY VALUE FOR ALL SPACES																			0.281

Mean RA score (main living spaces only) = 0.313
Annotated analysis score = 0.500
Space link ratio = 1.15
Square footage = 1258

Figure 21. Summary findings for a three bedroom single family detached house in Denver, CO.

Gamma analysis results. Figure 22 illustrates the computed versus predicted relative asymmetry values for the main living spaces of the three bedroom single family detached plan for Denver.

Room	Computed RA Values	Predicted RA Values	Result
Living	.212	.150 to .300	meets prediction
Kitchen	.258	.300 to .600	more integrated
Carrier	.258	.250 to .600	meets prediction
Bedroom	.333	> .400	more integrated
Bath	.348	> .400	more integrated
Bedroom	.379	> .400	more integrated

Figure 22. Computed versus predicted relative asymmetry values for a three bedroom single family detached house in Denver, CO.

The range of relative asymmetry values for this plan begins at the most integrated space, the living room, with a value of 0.212, and ends at the most segregated space, the bedrooms, with a value of 0.379; a range of 0.167. The plan appears to be well integrated throughout, with low relative asymmetry scores for all major living areas. The mean relative asymmetry score for the main living spaces is 0.313.

Annotated analysis results. The plan meets only 16 of 34 suggestions for a single family detached house and has an annotated analysis score of 0.500). The living room, dining room, and lack of a family room all contribute to the low score. The plan, while still seeming to differentiate between areas distinctly, does offer an open plan with all areas in close proximity. The small size of the house, three bedrooms in 1258 square feet, may make this a necessity.

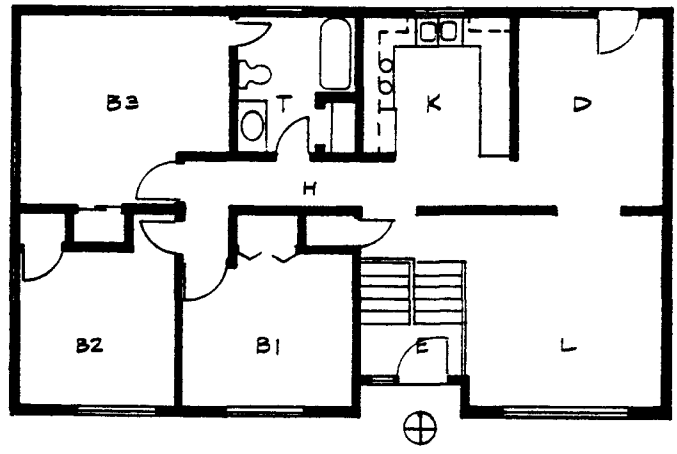
Summary and discussion. The plan illustrated in Figure 21 shows a plan that registers low relative asymmetry scores (highly

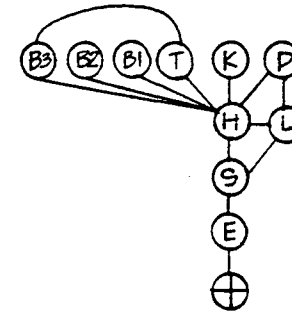
integrated), with a mean relative asymmetry score of 0.313. This could account for the less than perfect fit to the requirements for a single family detached house as described in the checklist (annotated analysis score = 0.500).

The plan has at least two rings (space link ratio = 1.15), both of which run through major living areas. The areas on the rings, with the exception of the entry, all have relative asymmetry scores that meet or exceed the predicted integration levels.

Providence: Three Bedroom Single Family Detached House

Figure 23 illustrates the floor plan, relative asymmetry table, gamma map and annotated analysis score for the three bedroom single family detached house in Providence, RI. The annotated checklist for this plan appears in Appendix F.





PROVIDENCE THREE BEDROOM SINGLE FAMILY DETACHED HOUSE

	*	E	G	L	F	D	K	B1	B2	B3	T1	T2	H1	H2	S1	S2	U1	MD	RA
*	0	1		2		1	3	3	3	3	3		2		2			2.30	0.289
E	1	0		2		2	3	3	3	3	3		2		1			2.30	0.289
G																			
L	2	2		0		1	2	2	2	2	2		1		1			1.70	0.156
F																			
D	1	2		1		0	2	2	2	2	2		1		2			1.70	0.156
K	3	3		2		2	0	2	2	2	2		1		2			2.10	0.244
B1	3	3		2		2	2	0	2	2	2		1		2			2.10	0.244
B2	3	3		2		2	2	2	0	2	2		1		2			2.10	0.244
B3	3	3		2		2	2	2	2	0	1		1		2			2.00	0.222
T1	3	3		2		2	2	2	2	1	0		1		2			2.00	0.222
T2																			
H1	2	2		1		1	1	1	1	1	1		0		1			1.20	0.044
H2																			
S1	2	1		1		2	2	2	2	2	2		1		0			1.70	0.156
S2																			
U1																			

MEAN RELATIVE ASYMMETRY VALUE FOR ALL SPACES: 0.206

Mean RA score (main living spaces only) = 0.222
Annotated analysis score = 0.630
Space link ratio = 1.36
Square footage = 1075

Figure 23. Summary findings for a three bedroom single family detached house in Providence, RI.

Gamma analysis results. Figure 24 illustrates the computed versus predicted relative asymmetry values for the main living spaces of the three bedroom single family detached plan for Providence.

Room	Computed RA Values	Predicted RA Values	Result
Living	.156	.150 to .300	meets prediction
Dining	.156	.200 to .500	more integrated
Bath	.222	> .400	more integrated
Bedroom	.222	> .400	more integrated
Kitchen	.244	.300 to .600	more integrated
Bedroom	.244	> .400	more integrated
Carrier	.289	.250 to .600	meets prediction

Figure 24. Computed versus predicted relative asymmetry values for a three bedroom single family detached house in Providence, RI.

The range of relative asymmetry values for this plan begins at the most integrated spaces, the living room and dining room, with a value of 0.156, and ends at the most segregated space, the carrier, with a value of 0.289; a range of 0.133. The plan appears to be very well integrated throughout, with low relative asymmetry scores for all major living areas. The mean relative asymmetry score for the main living areas is 0.222.

Annotated analysis results. The plan meets 22 of 30 suggestions for a single family detached house and has an annotated analysis score of 0.630). The living room and dining room contribute positively to the score, while the lack of a family room and the low score of the kitchen prevent the plan from scoring higher (Appendix F). The plan, while still seeming to differentiate between areas distinctly, does offer an open plan with all areas in close proximity.

Summary and discussion. The plan illustrated in Figure 23 shows a plan that registers low relative asymmetry scores (highly integrated), with a mean relative asymmetry score of 0.222. The plan also registers a reasonably good fit to the requirements for a single family detached house as described in the checklist (annotated analysis score = 0.630).

The plan has at least four rings (space link ratio = 1.36), all of which run through major living areas. The areas on the rings, with the exception of the entry, all have relative asymmetry scores that meet or exceed the predicted integration levels.

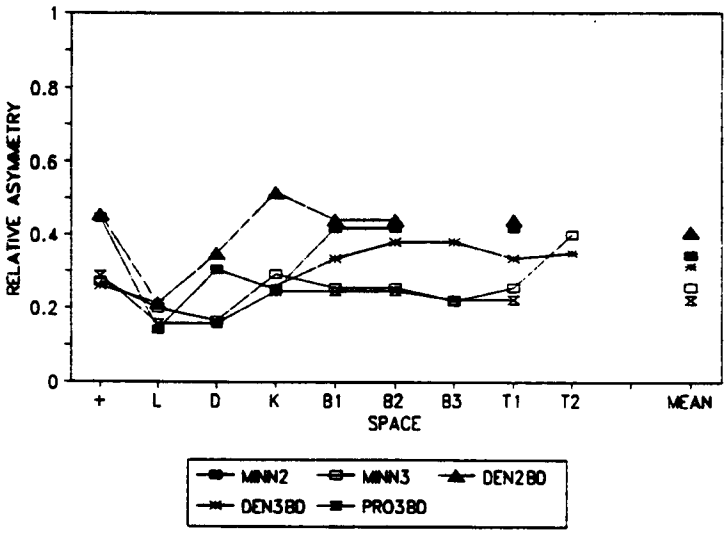
Summary and Discussion of Single Family Detached House Sample Gamma Analysis

A summary of the relative asymmetry values for the major living spaces of the single family detached houses is presented in Figure 25. Circulation and extraneous spaces were omitted from this list in order to provide a better comparison to the single parent family dwellings. A graph of the relative asymmetry values against each room in each house is also shown. This graph depicts each single family detached house under analysis and plots the relative asymmetry values by room as a means of comparing the spread of the relative asymmetry values among the plans. The range of relative asymmetry values is also presented. It was computed by subtracting the lowest relative asymmetry values from the highest relative asymmetry values. The computation was done only for the major living spaces of the houses, with the transition spaces excluded. The mean difference in the relative asymmetry values for this computation is 0.229. This value

will be compared to a similar value determined for the single parent dwellings later in this chapter. The expectation is that the mean difference in the highest to lowest scores will be greater, indicating a broader range of integration (relative asymmetry) values for the single family detached houses.

[redacted] OF RELATIVE ASYMMETRY VALUES FOR MAIN LIVING SPACES

	SINGLE FAMILY DETACHED HOUSES					
	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
+	0.444	0.273	0.455	0.258	0.289	0.344
L	0.139	0.200	0.212	0.212	0.156	0.184
D	0.306	0.164	0.348		0.156	0.243
K	0.290	0.291	0.515	0.258	0.244	0.312
B1	0.417	0.255	0.439	0.333	0.244	0.338
B2	0.417	0.255	0.439	0.379	0.244	0.347
B3		0.218		0.379	0.222	0.273
T1	0.417	0.255	0.439	0.333	0.222	0.333
T2		0.400		0.348		0.374
[redacted]	0.341	0.257	0.407	0.313	0.222	0.306
COUNT	7	9	7	8	8	
[redacted]	0.043	0.022	0.037	0.022	0.016	
[redacted]						0.306
[redacted]						7.6
[redacted]						0.032



Range of relative asymmetry values without transition spaces

	Minn2	Minn3	Den2	Den3	Pro3
high	0.444	0.400	0.515	0.379	0.289
low	0.139	0.164	0.212	0.212	0.156
range	0.305	0.236	0.303	0.167	0.133

mean range: 0.229

Annotated analysis score summary

	Minn2	Minn3	Den2	Den3	Pro3
score	0.540	0.790	0.460	0.500	0.630

mean annotated analysis score: 0.584

Figure 25. Summary values for single family detached houses.

The most integrated single family detached house under analysis is the house from Providence, with a mean relative asymmetry score of 0.222. The least integrated house is the two bedroom house from Denver, with a relative asymmetry score of 0.407. The average of the relative asymmetry scores for all the single family detached houses is 0.308.

Annotated Analysis

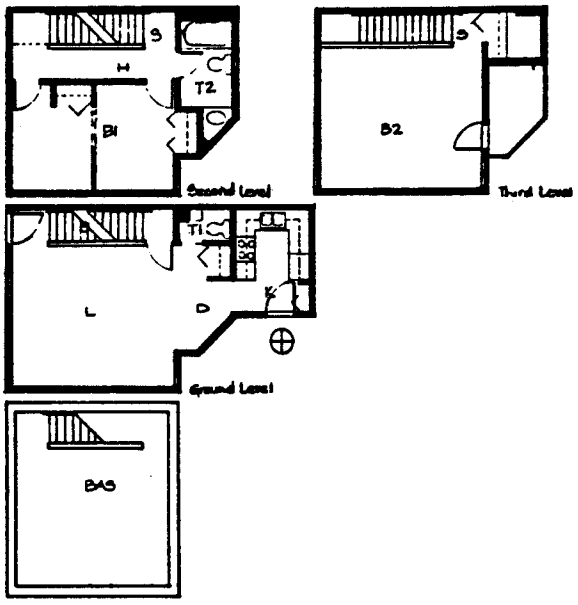
A summary of the annotated analysis is also included in Figure 25. The scores for each of the houses is presented along with the average score. The high annotated analysis score is registered by the three bedroom house from Minnesota, with a score of 0.790; the low score is registered by the two bedroom from Denver, with a score of 0.460. The average annotated analysis score is 0.584. The annotated analysis scores are intended to measure the fit of the house to the family type. The scale of the scoring ranges from zero to one, with a score of one being a perfect fit.

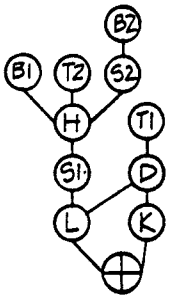
Single Parent Family Dwellings

The results for each unit will be presented individually. The cumulation will be a summary of the entire group.

St. Paul: Two Bedroom Single Parent Family Dwelling

Figure 26 illustrates the floor plan, relative asymmetry table, gamma map and annotated analysis score for the two bedroom single parent family dwelling in Dayton Court, St. Paul. The annotated checklist for this plan appears in Appendix F.





DAYTON COURT TWO BEDROOM SINGLE PARENT FAMILY DWELLING

	*	E	G	L	F	D	K	B1	B2	B3	T1	T2	N1	N2	S1	S2	UN	MD	RA
*	0			1		2	1	4	5		3	4	3		2	4		2.90	0.422
E																			
G																			
L	1			0		1	2	3	4		2	3	2		1	3		2.20	0.267
F																			
D	2			1		0	1	4	5		1	4	3		2	4		2.70	0.378
K	1			2		1	0	5	6		2	5	4		3	5		3.40	0.533
B1	4			3		4	5	0	1		5	2	1		2	2		3.10	0.467
B2	5			4		5	6	1	0		6	3	2		3	1		3.80	0.622
B3																			
T1	3			2		1	2	5	6		0	5	4		3	5		3.60	0.578
T2	4			3		4	5	2	3		5	0	1		2	2		3.10	0.467
N1	3			2		3	4	1	2		4	1	0		1	1		2.20	0.267
N2																			
S1	2			1		2	3	2	3		2	2	1		0	2		2.00	0.222
S2	4			3		4	5	2	1		5	2	1		2	0		2.90	0.422
UN																			
MEAN RELATIVE ASYMMETRY VALUES FOR ALL SPACES																			0.422

Mean RA score (main living spaces only) = 0.467
Annotated analysis score = 0.710
Space link ratio = 1.09
Square footage = 1175

Figure 26. Summary findings for a two bedroom single parent family dwelling in Dayton Court, St. Paul, MN.

Gamma analysis results. Figure 27 lists the computed versus

Room	Computed RA Values	Predicted RA Values	Result
Living	.267	.150 to .300	meets prediction
Dining	.378	.200 to .400	meets prediction
Carrier	.422	.300 to .500	meets prediction
Bathroom	.461	> .350	meets prediction
Bedroom	.467	> .350	meets prediction
Kitchen	.533	.200 to .400	less integrated
Bathroom	.578	> .350	meets prediction
Bedroom	.622	> .350	meets prediction

Figure 27. Computed versus predicted relative asymmetry values for the two bedroom unit at Dayton Court, St. Paul, MN.

predicted relative asymmetry values for the main living spaces of the two bedroom unit at Dayton Court.

The unit meets all predicted values for the spaces of a single parent dwelling except one, the kitchen, which is much less integrated than expected. The mean relative asymmetry value is high (0.467). This indicates a segregated spatial arrangement. The range of relative asymmetry is also high, with a low value (most integrated) of 0.267 (living room) and a high value (least integrated) of 0.622 (bedroom) for a range of 0.355.

Annotated analysis results. The plan meets 18 of the 26 suggestions for a single parent family dwelling as demonstrated in the checklist and has an annotated analysis score of 0.710. High scores were recorded for the living room and outdoor space (1.000), while the kitchen scored lower (0.333). See Appendix F for more details.

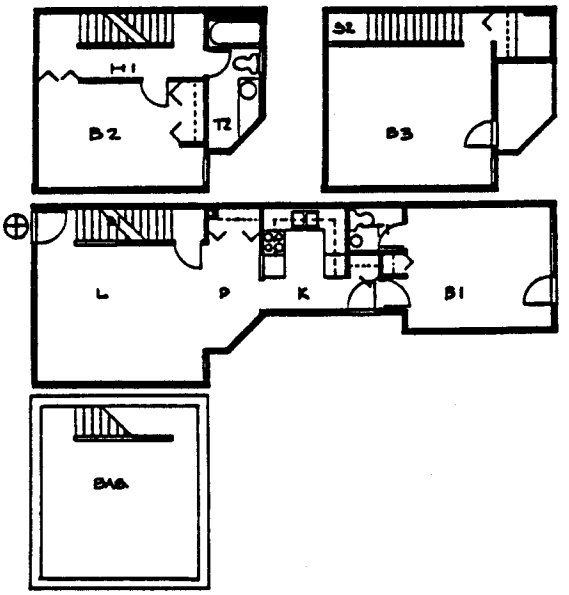
Summary and discussion. This plan receives mediocre scores from both methods in terms of its fit for single parent families (gamma

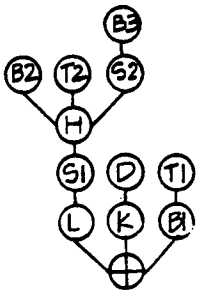
analysis mean score of 0.467 and annotated analysis score of 0.710). Yet the plan still offers features that are beneficial to the single parent family. The plan is compact, two bedrooms in 1175 square feet, and the three story stacking allows each unit of the complex direct outdoor access.

The space link ratio (1.09) indicates a fairly linear space. There is only one ring. It passes through the most integrated part of the plan, the living room, as well as one of the most segregated parts of the plan, the kitchen.

St. Paul: Three Bedroom Single Parent Family Dwelling

Figure 28 illustrates the floor plan, relative asymmetry table, gamma map and annotated analysis score for the three bedroom single parent family dwelling in Dayton Court, St. Paul. The annotated checklist for this plan appears in Appendix F.





DAYTON COURT THREE BEDROOM SINGLE PARENT FAMILY DWELLING

	*	B	G	L	F	D	K	B1	B2	B3	T1	T2	H1	H2	S1	S2	U9	MD	RA
*	0			1		2	1	1	4	5	2	4	3		2	4		2.64	0.327
B																			
G																			
L	1			0		1	2	3	3	4	4	3	2		1	3		2.45	0.291
F																			
D	2			1		0	1	2	5	6	3	5	4		2	5		3.27	0.455
K	1			2		1	0	1	5	6	2	5	4		3	5		3.18	0.436
B1	1			2		2	1	0	5	6	1	5	4		3	5		3.18	0.436
B2	4			3		4	5	5	0	3	6	2	1		2	2		3.36	0.473
B3	5			4		6	5	6	3	0	7	3	2		3	3		4.27	0.655
T1	2			3		3	2	1	6	7	0	6	5		4	6		4.09	0.618
T2	4			3		4	5	5	2	3	6	0	1		2	2		3.36	0.473
H1	3			2		3	4	4	1	2	5	1	0		1	1		2.45	0.291
H2																			
S1	2			1		2	3	3	2	3	4	2	1		0	2		2.27	0.255
S2	4			3		4	5	5	2	3	6	2	1		2	0		3.36	0.473
U9																			
MEAN RELATIVE ASYMMETRY VALUE FOR ALL SPACES																			0.432

Mean RA score (main living spaces only) = 0.463
Annotated analysis score = 0.640
Space link ratio = 1.08
Square footage = 1425

Figure 28. Summary findings for a three bedroom single parent family dwelling in Dayton Court, St. Paul, MN.

Gamma analysis results. Figure 29 lists the computed versus

Room	Computed RA Values	Predicted RA Values	Result
Living	.291	.150 to .300	meets prediction
Carrier	.327	.300 to .500	meets prediction
Kitchen	.436	.200 to .400	less integrated
Bedroom 1	.436	> .350	meets prediction
Dining	.455	.200 to .400	less integrated
Bathroom	.473	> .350	meets prediction
Bedroom 2	.473	> .350	meets prediction
Bathroom 2	.618	> .350	meets prediction
Bedroom 3	.655	> .350	meets prediction

Figure 29. Computed versus predicted relative asymmetry values for the three bedroom unit at Dayton Court, St. Paul, MN.

predicted relative asymmetry values for the main living spaces of the three bedroom unit at Dayton Court.

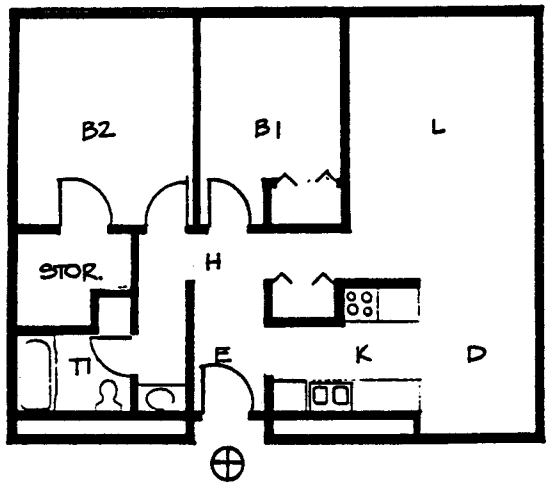
This plan, like the two bedroom plan from Dayton Court, meets the relative asymmetry value predictions for a single parent family dwelling with two exceptions, the kitchen and the dining room, both of which are less integrated than expected. The mean relative asymmetry value for the main living spaces of the plan is 0.463. The range of relative asymmetry values is 0.364. The lowest value (0.291) is found in the living room, and the highest value (0.655) is found at a bedroom.

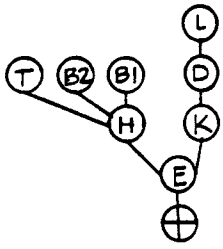
Annotated analysis results. The plan meets 17 of the 26 suggestions for a single parent family dwelling and has an annotated analysis score of 0.640 (Appendix F). High scores were recorded for the living room and outdoor space (1.000), while the kitchen scored lower (0.333).

Summary and discussion. Neither the gamma analysis (mean relative asymmetry score = 0.463) nor the annotated analysis (annotated analysis score = 0.640) suggest this plan is well suited to single parent families. However some features of the plan would seem to indicate otherwise; the bedroom/studio/office is one such feature. The plan does seem to diffuse control with a space link ratio of 1.08. There are at least three rings, all passing through the kitchen.

Denver: Two Bedroom Single Parent Family Dwelling

Figure 30 illustrates the floor plan, relative asymmetry table, gamma map and annotated analysis score for the two bedroom single parent family dwelling in Warren Village, Denver. The annotated checklist for this plan appears in Appendix F.





WARREN VILLAGE TWO BEDROOM SINGLE PARENT FAMILY DWELLING

	*	E	G	L	F	D	K	B1	B2	B3	T1	T2	H1	H2	S1	S2	UN	MD	RA
*	0	1		3		3	2	3	3		3		2					2.50	0.429
E	1	0		2		2	1	2	2		2		1					1.63	0.179
G																			
L	3	2		0		1	2	2	2		2		1					1.88	0.250
F																			
D	3	2		1		0	1	2	2		2		1					1.75	0.214
K	2	1		2		1	0	3	3		3		2					2.13	0.321
B1	3	2		2		2	3	0	2		2		1					2.13	0.321
B2	3	2		2		2	3	2	0		2		1					2.13	0.321
B3																			
T1	3	2		2		2	3	2	2		0		1					2.13	0.321
T2																			
H1	2	1		1		1	2	1	1		1		0					1.25	0.071
H2																			
S1																			
S2																			
UN																			

MEAN RELATIVE ASYMMETRY VALUE FOR ALL SPACES: 0.270

Mean RA scores (main living spaces only) = 0.311
Annotated analysis score = 0.210
Space link ratio = 1.22
Square footage = 952

Figure 30. Summary findings for a two bedroom single parent family dwelling in Warren Village, Denver, CO.

Gamma analysis results. Figure 31 illustrates the computed versus predicted relative asymmetry values for the main living areas of the two bedroom single parent family dwelling for Denver.

Room	Computed RA Values	Predicted RA Values	Result
Dining	.214	.200 to .400	meets prediction
Living	.250	.150 to .300	meets prediction
Kitchen	.321	.200 to .400	meets prediction
Bedroom	.321	> .350	more integrated
Bath	.321	> .350	more integrated
Carrier	.429	.300 to .500	meets prediction

Figure 31. Computed versus predicted relative asymmetry values for a two bedroom single parent family dwelling in Warren Village, Denver, CO.

The range of relative asymmetry values for this plan begins at the most integrated space, the dining room, with a value of 0.214, and ends at the most segregated space, the carrier, with a value of 0.429; a range of 0.215. The mean relative asymmetry value for this plan is 0.311, indicating a fairly integrated plan.

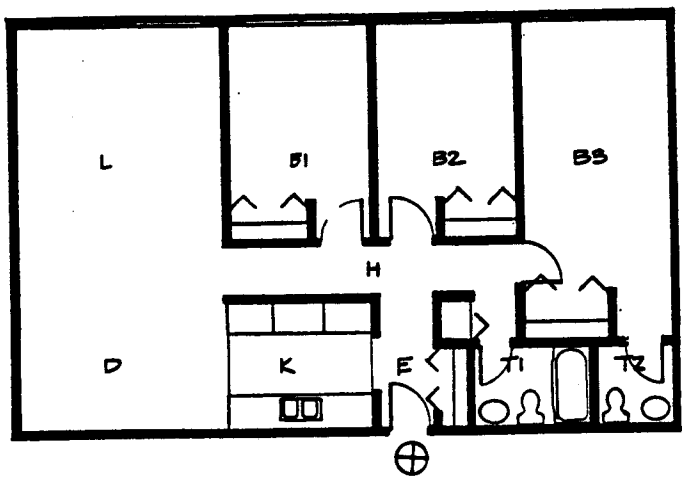
Annotated analysis results. The house meets only 6 of the 22 suggestions for a single parent family dwelling as described on the annotated checklist and has an annotated analysis score of 0.210 (Appendix F). Some of the failings of the plan may be accounted for by the lack of direct bathroom access and privacy.

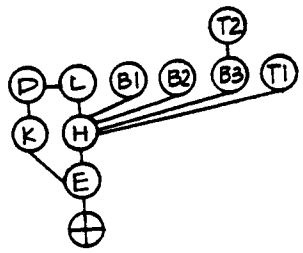
Summary and discussion. The plan of the two bedroom single parent family dwelling from Warren Village in Denver appears to contain a series of integrated spaces (mean relative asymmetry value = 0.311) but to also exhibit a weak fit as a dwelling for a single

parent family (annotated analysis score = 0.210). This contradiction could stem from the arrangement of the plan around a hallway; the spaces are linked by the hall leading to potentially low relative asymmetry scores, yet the hall decreases real privacy and inhibits visual access between rooms. The plan has three rings that pass through the major living areas (space link ratio = 1.22), and perhaps add to the integrated nature of the layout.

Denver: Three Bedroom Single Parent Family Dwelling

Figure 32 illustrates the floor plan, relative asymmetry table, gamma map and annotated analysis score for the three bedroom single parent family dwelling in Warren Village, Denver. The annotated checklist for this plan appears in Appendix F.





	*	B	G	L	F	D	K	B1	B2	B3	T1	T2	H1	H2	S1	S2	U8	MD	RA
*	0	1		3		3	2	3	3	3	3	4	2					2.70	0.378
B	1	0		2		2	1	2	2	2	2	3	1					1.80	0.178
G																			
L	3	2		0		1	2	2	2	2	2	3	1					2.00	0.222
F																			
D	3	3		1		0	1	3	3	3	3	4	2					2.80	0.333
K	2	1		2		1	0	3	3	3	3	4	2					2.40	0.311
B1	3	2		2		3	3	0	2	2	2	3	1					2.30	0.289
B2	3	2		2		3	3	2	0	2	2	3	1					2.30	0.289
B3	3	2		2		3	3	2	2	0	2	1	1					2.10	0.244
T1	3	2		2		3	3	2	2	2	0	3	1					2.30	0.289
T2	4	3		3		4	4	3	3	1	3	0	2					3.00	0.444
H1	2	1		1		2	2	1	1	1	1	2	0					1.40	0.089
H2																			
S1																			
S2																			
U8																			
MEAN RELATIVE ASYMMETRY VALUE FOR ALL SPACES																			0.279

Mean RA score (main living spaces only) = 0.311
Annotated analysis score = 0.450
Space link ratio = 1.09
Square footage = 1204

Figure 32. Summary findings for a three bedroom single parent family dwelling in Warren Village, Denver, CO.

Gamma analysis results. Figure 33 illustrates the computed versus predicted relative asymmetry values for the main living spaces of the three bedroom single parent family dwelling for Denver.

Room	Computed RA Values	Predicted RA Values	Result
Living	.222	.150 to .300	meets prediction
Bedroom 3	.244	> .350	more integrated
Bedrooms 1&3	.289	> .350	more integrated
Bath	.289	> .350	more integrated
Kitchen	.311	.200 to .400	meets prediction
Dining	.333	.200 to .400	meets prediction
Carrier	.378	.300 to .500	meets prediction
Bath 2	.444	> .350	meets prediction

Figure 33. Computed versus predicted relative asymmetry values for a three bedroom single parent family dwelling in Warren Village, Denver, CO.

The range of relative asymmetry values for this plan begins at the most integrated space, the living room, with a value of 0.222, and ends at the most segregated space, a bathroom, with a value of 0.444; a range of 0.222. The mean relative asymmetry value for this plan is 0.311, indicating a well integrated plan.

Annotated analysis results. The house meets only 8 of the 22 suggestions for a single parent family dwelling as described on the annotated checklist and has an annotated analysis score of 0.450 (Appendix F).

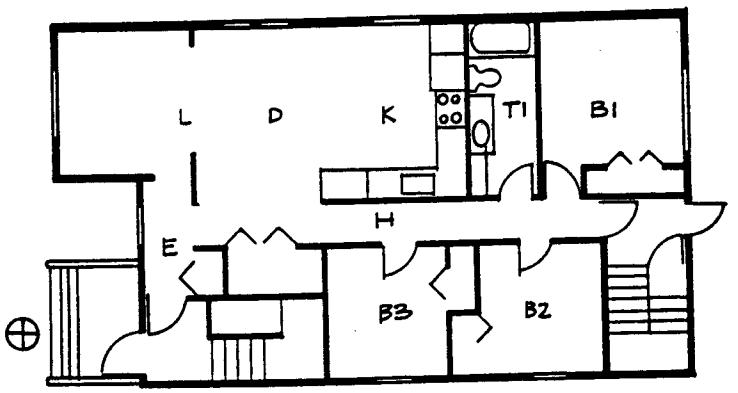
Summary and discussion. The plan of the three bedroom single parent family dwelling from Warren Village in Denver is just as integrated (mean relative asymmetry score = 0.311) overall as its two bedroom counterpart (mean relative asymmetry score = 0.311). As in the two bedroom unit (annotated analysis score = 0.210), the plan

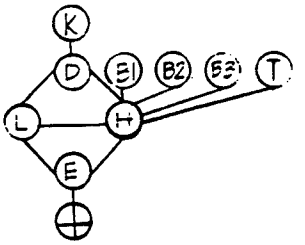
exhibits a weak fit as a dwelling for a single parent family according to the annotated analysis (annotated analysis score = 0.450). This contradiction of the methods could stem from the arrangement of the plan around a hallway. Just as in the two bedroom plan, the spaces are linked by the hall leading to potentially low relative asymmetry scores, yet the hall decreases real privacy and inhibits visual access between rooms.

The plan has only one ring through the major living areas (space link ratio = 1.09). This ring links only the kitchen, dining, living and entry. The hallway serves as the access from the living areas to the sleeping areas.

Providence: Three Bedroom Single Parent Family Dwelling

Figure 34 illustrates the floor plan, relative asymmetry table, gamma map and annotated analysis score for the three bedroom single parent family dwelling as designed by the Women's Development Corporation in Providence, RI. The annotated checklist for this plan appears in Appendix F.





WOMEN'S DEVELOPMENT CORP. PROVIDENCE THREE BEDROOM SINGLE PARENT DWELLING

	⌖	E	G	L	F	D	K	B1	B2	B3	T1	T2	H1	H2	S1	S2	UN	MD	RA
⌖	0	1		2		3	4	3	3	3	3		2					2.67	0.417
E	1	0		1		2	3	2	2	2	2		1					1.78	0.194
G																			
L	2	1		0		1	2	2	2	2	2		1					1.67	0.167
F																			
D	3	2		1		0	1	2	2	2	2		1					1.78	0.194
K	4	3		2		1	0	3	3	3	3		2					2.67	0.417
B1	3	2		2		2	3	0	2	2	2		1					2.11	0.278
B2	3	2		2		2	3	2	0	2	2		1					2.11	0.278
B3	3	2		2		2	3	2	2	0	2		1					2.11	0.278
T1	3	2		2		2	3	2	2	2	0		1					2.11	0.278
T2																			
H1	2	1		1		1	2	1	1	1	1		0					1.22	0.056
H2																			
S1																			
S2																			
UN																			
MEAN RELATIVE ASYMMETRY VALUE FOR ALL SPACES																			0.256

Mean RA score (main living spaces only) = 0.288
Annotated analysis score = 0.620
Space link ratio = 1.20
Square footage = 960

Figure 34. Summary findings for a three bedroom single parent family dwelling as designed by the Women's Development Corporation in Providence, RI.

Gamma analysis results. Figure 35 illustrates the computed versus predicted relative asymmetry values for the main living spaces of the three bedroom single parent family dwelling for Providence.

Room	Computed RA Values	Predicted RA Values	Result
Living	.167	.150 to .300	meets prediction
Dining	.194	.200 to .400	meets prediction
Bedrooms	.278	> .350	more integrated
Bath	.278	> .350	more integrated
Kitchen	.417	.200 to .400	meets prediction
Carrier	.417	.300 to .500	meets prediction

Figure 35. Computed versus predicted relative asymmetry values for a three bedroom single parent family dwelling in Providence, RI.

The range of relative asymmetry values for this plan begins at the most integrated space, the living room, with a value of 0.167, and ends at the most segregated space, the kitchen, with a value of 0.417; a range of 0.250. The mean relative asymmetry value for this plan is 0.288, indicating a well integrated plan.

Annotated analysis results. The house meets 15 of the 22 suggestions for a single parent family dwelling as described on the annotated checklist and has an annotated analysis score of 0.620 (Appendix F).

Summary and discussion. The plan of the three bedroom single parent family dwelling from Providence is relatively well integrated (mean relative asymmetry score = 0.288). Its fit to the single parent family is marginal, with an annotated analysis score of 0.620.

The plan has only three rings through the major living areas (space link ratio = 1.20). This ring links the dining room, living room and entry.

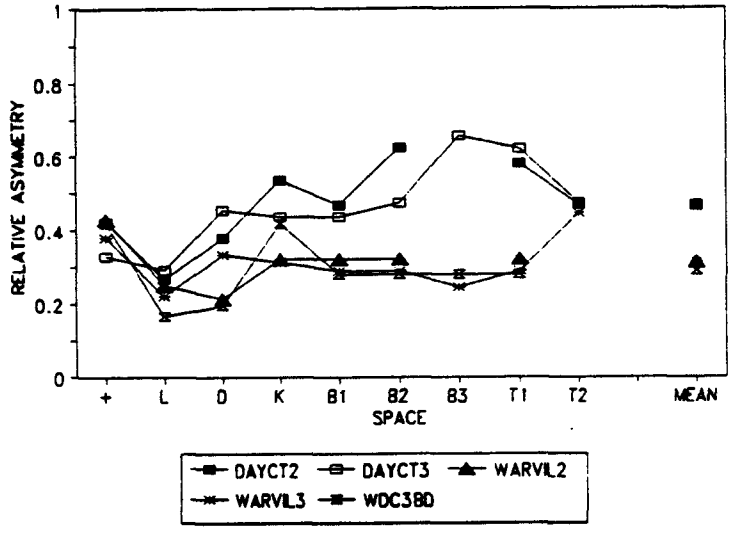
Summary and Discussion of Single Parent Family Dwelling Sample Gamma Analysis

A summary of the relative asymmetry values for the major living spaces of the single parent family dwellings are presented in Figure 36. Circulation and extraneous spaces were omitted from this list in order to provide a better comparison to the single parent family dwellings. A graph of the relative asymmetry values against each room in each house is also shown. This graph depicts each single parent family dwelling under analysis and plots the relative asymmetry values by room as a means of comparing the spread of the relative asymmetry values among the plans. The range of relative asymmetry values is also presented. It was computed by subtracting the lowest relative asymmetry values from the highest relative asymmetry values. The computation was done only for the major living spaces of the units, with the transition spaces excluded. The mean difference in the relative asymmetry values for this computation is 0.281. This value will be compared to a similar value determined for the single family detached houses. The expectation is that this value will be greater for the single family detached houses than for the single parent family units, indicating a broader range of integration (relative asymmetry) values, or more fluctuation between integrated and segregated spaces, for the single family detached houses.

SUMMARY OF RELATIVE ASYMMETRY VALUES FOR MAIN LIVING SPACES

SINGLE PARENT FAMILY DWELLINGS

	DAYCT2	DAYCT3	WARVIL2	WARVIL3	WDC3	RM MEAN
+	0.622	0.327	0.429	0.378	0.417	0.395
L	0.267	0.291	0.250	0.222	0.167	0.239
D	0.378	0.455	0.214	0.333	0.194	0.315
K	0.533	0.436	0.321	0.311	0.417	0.404
B1	0.467	0.436	0.321	0.289	0.278	0.358
B2	0.622	0.473	0.321	0.289	0.278	0.397
B3		0.655		0.244	0.278	0.392
T1	0.578	0.618	0.321	0.289	0.278	0.417
T2	0.467	0.473		0.444		0.461
MEAN	0.467	0.463	0.311	0.311	0.286	0.376
COUNT	8	9	7	9	8	
SE	0.040	0.039	0.026	0.023	0.032	
GRAND MEAN						0.368
MEAN COUNT (AVG. NUMBER OF SPACES)						8.2
GRAND STANDARD ERROR						0.040



Range of relative asymmetry values without transition spaces

	Dayct2	Dayct3	Warvil2	Warvil3	WDC3
high	0.622	0.655	0.429	0.444	0.417
low	0.267	0.291	0.214	0.222	0.167
range	0.355	0.364	0.215	0.222	0.250

mean range: 0.281

Annotated analysis score summary

	Dayct2	Dayct3	Warvil2	Warvil3	WDC3
score	0.710	0.640	0.210	0.450	0.620

mean annotated analysis score: 0.526

Figure 36. Summary values for single parent family dwellings.

The most integrated single parent family dwelling under analysis is the unit from Providence, with a mean relative asymmetry score of 0.288. The least integrated house is the two bedroom dwelling from Minnesota, with a relative asymmetry score of 0.467. The average of the relative asymmetry scores for all the single parent family dwellings is 0.368.

Annotated Analysis

A summary of the annotated analysis is also included in Figure 36. The scores for each of the houses is presented along with the average score. The highest annotated analysis score is registered by the two bedroom unit from Minnesota, with a score of 0.710; the lowest score is registered by the two bedroom from Denver, with a score of 0.210. The average annotated analysis score is 0.526. The annotated analysis scores are intended to measure the fit of the house to the family type. The scale of the scoring ranges from zero to one, with a score of one being a perfect fit.

Comparison of Single Family Detached Houses and Dwellings for Single Parent Families

Gamma Analysis Results

Figure 37 illustrates the summary values for both housing types under analysis. Included are the relative asymmetry values for each major living space, their means and the grand means. An examination of the relative asymmetry values indicates lower values (more integrated space) for the single family detached houses (grand mean = 0.308) than for the single parent family dwellings (grand mean = 0.368). A two-tailed t-test was conducted on these results (Appendix

SUMMARY OF RELATIVE ASYMMETRY VALUES FOR MAJOR LIVING SPACES

	SINGLE FAMILY DETACHED HOUSES						SINGLE PARENT FAMILY DWELLINGS					
	MINN2	MINN3	DEN2BD	DEN3BD	PRO3BD	RM MEAN	DAYCT2	DAYCT3	WARVIL2	WARVIL3	WDC3BD	RM MEAN
A	0.444	0.273	0.455	0.258	0.289	0.344	0.422	0.327	0.429	0.378	0.417	0.395
L	0.139	0.200	0.212	0.212	0.156	0.184	0.267	0.291	0.250	0.222	0.167	0.239
D	0.306	0.164	0.348		0.156	0.243	0.378	0.455	0.214	0.333	0.194	0.315
K	0.250	0.291	0.515	0.258	0.244	0.312	0.533	0.436	0.321	0.311	0.417	0.404
B1	0.417	0.255	0.439	0.333	0.244	0.338	0.467	0.436	0.321	0.289	0.278	0.358
B2	0.417	0.255	0.439	0.379	0.244	0.347	0.622	0.473	0.321	0.289	0.278	0.397
B3		0.218		0.379	0.222	0.273		0.655		0.244	0.278	0.392
T1	0.417	0.255	0.439	0.333	0.222	0.333	0.578	0.618	0.321	0.289	0.278	0.417
T2		0.400		0.348		0.374	0.467	0.473		0.444		0.461
MEAN	0.341	0.257	0.407	0.313	0.222	0.305	0.467	0.463	0.311	0.311	0.288	0.378
COUNT	7	9	7	8	8		8	9	7	9	8	
SE	0.043	0.022	0.037	0.022	0.016		0.040	0.039	0.026	0.023	0.032	
GRAND MEAN FOR SINGLE FAMILY DETACHED HOUSES						0.308	GRAND MEAN FOR SINGLE PARENT FAMILY DWELLINGS					0.368
MEAN COUNT (AVG. NUMBER OF SPACES)						7.8	MEAN COUNT (AVG. NUMBER OF SPACES)					8.2
GRAND STANDARD ERROR						0.032	GRAND STANDARD ERROR					0.040

Mean range of relative asymmetry values

	Single family	Single parent
Mean range	0.229	0.288

Figure 37. Summary values for single family detached houses and single parent family dwellings.

G). The results indicate that there is no significant difference in the relative asymmetry values for the two housing types ($p = 0.276$). It was expected that the single family dwellings would score higher on the relative asymmetry scale, indicating a higher degree of segregation. This is not the case for the plans presented here. In order to further clarify the differences, or lack thereof, between the two types of spaces, the means of the relative asymmetry values for the major living areas in each plan were plotted. This graph appears in Figure 38.

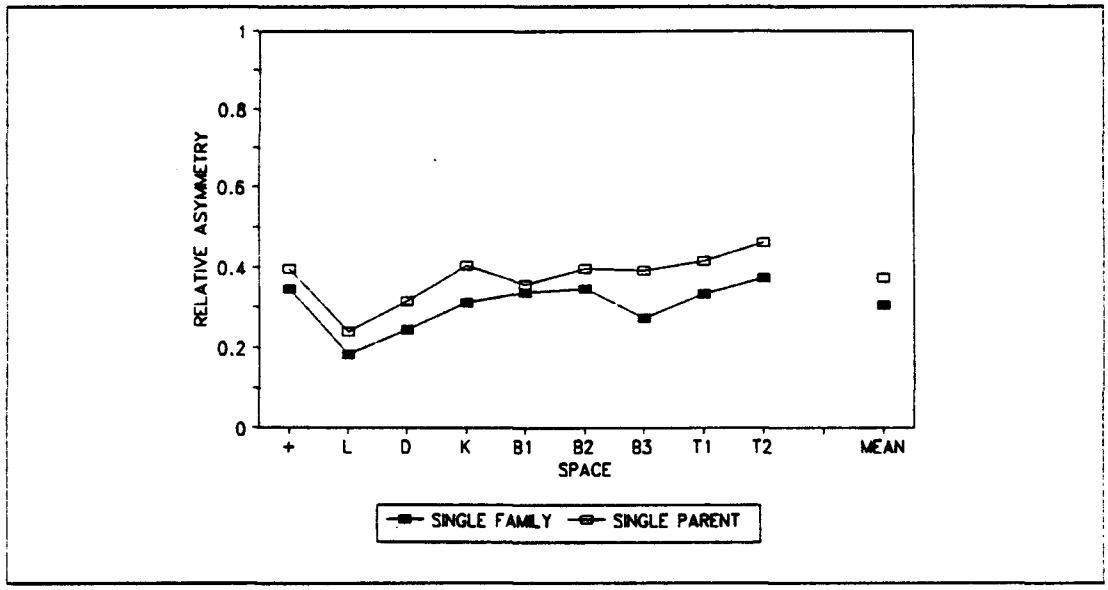


Figure 38. Graph of the means of the relative asymmetry values, by major living area, for the single family detached houses and the single parent family dwellings.

Additionally, the expected range of the relative asymmetry values do not meet predictions. It was expected that the range of values of the single family detached house would be greater than the range of values for the single parent family dwelling as a reflection of the expected higher segregation of the former dwelling type. However, the range of values for the single family dwellings is lower (0.229) than the values for the single parent family dwellings (0.288). This seems to indicate that, for this sample, there is a closer relationship between the rooms of a single family detached house than for the rooms in a single parent family dwelling.

Annotated Analysis Results

Figure 39 illustrates the summary results of the annotated analysis. The goodness of fit between the plan and the family type based on the annotated analysis is marginal at best. The single

Annotated Analysis Summary Results

Single Family Detached Houses

	Minn2	Minn3	Denver2	Denver3	Prov3	Mean
Ann. Ana.	0.540	0.790	0.460	0.500	0.630	0.584

Single Parent Family Dwellings

	Dayct2	Dayct3	Warvil2	Warvil3	Prov.	Mean
Ann. Ana.	0.710	0.640	0.210	0.450	0.620	0.526

Figure 39. Summary of annotated analysis scores for single family detached houses and single parent family dwellings.

family detached houses fit their intended family type, the nuclear family, better (mean = 0.584) than do the dwellings designed for the single parent families (mean = 0.526). This is perhaps due to a long social history of design with the nuclear family type in mind. However, despite the difference in the means, the two-tailed t-test (Appendix G) performed on the annotated analysis scores revealed no significant difference in the fit of each house to its respective family type ($p = 0.604$).

Summary and Discussion

When the integration values (relative asymmetry) of the individual rooms are examined via the graph of Figure 38, an interesting pattern emerges. The two groups of housing follow an almost identical line across the graph. The relative asymmetry values, while not identical, follow a similar pattern of ranking indicating the single (nuclear) family detached house and the single parent family dwelling are very similar in their spatial make-up. The spaces of relaxation, the living and dining rooms, are still the

Room hierarchies by mean relative asymmetry values

Single Family	Room	RA Value
Most integrated	Living room	(0.184)
	Dining room	(0.243)
	Bedroom 3	(0.273)
	Kitchen	(0.312)
	Bathroom 1	(0.333)
	Bedroom 1	(0.338)
	Carrier	(0.344)
	Bedroom 2	(0.347)
Most segregated	Bathroom 2	(0.374)

Single Parent	Room	RA Value
Most integrated	Living room	(0.239)
	Dining room	(0.315)
	Bedroom 1	(0.358)
	Bedroom 3	(0.392)
	Carrier	(0.395)
	Bedroom 2	(0.397)
	Kitchen	(0.404)
	Bathroom 1	(0.417)
Most segregated	Bathroom 2	(0.461)

Figure 40. Room hierarchies by relative asymmetry values for single parent and single family housing.

public (more integrated) rooms of the house. The bedrooms and bathrooms are the most segregated due to privacy needs. The kitchen is the least integrated of the public rooms. The room hierarchies for both housing types are illustrated in Figure 40.

Taken together, the two analysis methods offer an interesting explanation of the space of family life for the two family types. The gamma analysis results offer a view of housing for two very different families that is essentially the same. The annotated analysis further states that the fit of the houses to the families is also similar. For a variety of reasons, development restrictions and cost among them, the single parent family homes described here do not display the

kinds of differences from single family detached housing that were expected. The same hierarchies of rooms apply to these plans as to the single family detached house plans. The traditional spaces of women, such as the kitchen, are still the more segregated or hidden spaces. Anthony, Weidemann, & Chin (1990) claim that the way in which the house is planned and designed may be a significant component of overall life satisfaction for single parent families. This leads to several questions. If the dwellings are not really designed to meet the needs of the single parent family, whose needs do they meet? Is the shape of the house as important as many researchers feel it is or are neighborhood concerns more influential on a single parent family? Can we develop housing alternatives that are true alternatives given the strong social and design bias toward single family detached housing?

CHAPTER V

SUMMARY, IMPLICATIONS, AND RECOMMENDATIONS

Summary

The intent of this study was to examine what, if any, differences occur in the spatial orientation of housing designed for single parent families and housing designed for the nuclear family. Room layout in relation to use and commonly accepted social function was examined. Two methods of analyses were employed: gamma analysis as developed by Hillier and Hanson in 1984 and annotated analysis developed specifically for this research. The method of gamma analysis (Hillier & Hanson, 1984) was used to determine if the housing as designed for the two family types was different in form, while the annotated analysis measured the "fit" of the housing for each of the family types.

The objectives of this study were: 1) to establish a single family detached house and a single parent family dwelling checklist for the annotated analysis (Appendices A - D) in order to determine the fit of the housing for each family type, 2) to evaluate the floor plans pertinent to the study with the annotation analysis checklists in order to determine if the houses meet the needs of the family types in question, 3) to determine predicted values of relative asymmetry (Hillier & Hanson, 1984), 4) to use the method of gamma analysis (Hillier & Hanson, 1984) to determine if the distribution of rooms within the dwelling unit of each type of housing is different, 5) to compare the findings of the two analyses methods, and 6) to discuss

the implications of these findings in terms of social expectations and attitudes surrounding the populations in question.

The data were collected by examining floor plans of units in existing and proposed developments that were specifically designed for single parent families and comparing them to floor plans of typical single family detached starter homes. The plans were matched for city, number of bedrooms and square footage. The single family detached house plans were obtained from Century-21 Real Estate offices in each of the cities where single parent housing exists or is proposed. The sample was small primarily due to the lack of developments specifically designed for single parent families and partially due to an inability to obtain floor plans.

Gamma analysis, as developed by Hillier and Hanson (1984) is a method of abstracting space in order to discover the social hierarchies inherent in it. It uses the notion of the permeability of space as an indicator of integration and segregation of space (quantitatively measured as relative asymmetry). The gamma analysis performed here revealed the mean relative asymmetry value of the single family detached houses was lower (0.308), indicating a higher degree of integration, than the mean relative asymmetry value of the single parent family dwellings (0.368). This difference was not found to be statistically significant, however ($p = 0.276$). This result was not the original expectation. It was expected, based on an examination of the literature, that homes for single parent families would be more integrated, have more connections between spaces and be less hierarchical in layout than the homes for nuclear families. The

results presented here suggest that despite the differences in the spatial needs of the two types of families, single parent families and nuclear families, the houses have a similar interior configuration. The hierarchies and segregation of spaces expressed within the house, especially those that run counter to family needs, could be a factor in role strain within the family.

Annotated analysis was developed specifically for this research. The intent of annotated analysis is to determine the fit of the house floor plan to the family type based on the expectations presented in the literature. The annotated analysis shows a better fit for the single family detached houses to their intended family (the nuclear family), with a mean score of 0.584, than the fit of the single parent family dwellings to their intended family type (mean score 0.526). However, this difference was not found to be statistically significant ($p = 0.604$, Appendix G).

Implications

This research can be of use to four segments of the population. They are designers of homes, housing developers, planners and policy makers, and researchers.

That the dwellings seem to address the needs of only one family type could be of interest to designers. Designers are often at the forefront of creating new spaces for families. Examining what is claimed versus what exists via the methods described in this study could offer assistance toward developing new spaces that truly meet needs.

Housing developers, for the same reasons as described for designers also can benefit from this research. Developers carry more and more influence over the shape of our landscape. They are in a position to offer alternatives in the market but often are reluctant to do so due to financial concerns. Eventually, as housing costs continue to skyrocket and the shape of housing no longer fits American families, innovative developers will respond with new spaces.

To aid developers with the institution of new housing forms, planners and policy makers must be willing to revise zoning ordinances. That the housing forms for two very different family types are similar in configuration may be due in part to zoning issues that still attempt to mandate what a family should be and what a family home and neighborhood should look like. Housing needs are going unmet and planners and policy makers need to take note.

Perhaps the most obvious group that may find this research interesting are researchers in housing and design. There are many more factors involved in housing for single parent and nuclear families than have been dealt with here. Issues of choice, affordability, and access are a few. The methods and conclusions presented here can lead to projects investigating other housing forms and other family types.

Recommendations for Further Research

1) The present study examined relative few houses and unit types, this is due to the lack of housing designed specifically for single parent families. However, many examples of single family detached housing exist and further research into the typology of single family

detached housing could be interesting. For example, is there an archetypal single family detached house in the United States?

2) Economic information was not considered in this study. This important factor certainly effects housing choices and could effect design and floor plan as well. Examining floor plans of various houses based on cost may illuminate social and economic theories of class.

3) Further research needs to be done to improve and refine the methods of gamma analysis and annotated analysis as applied to housing studies. A large sample study of single family detached houses, for example, can help impart a better understanding of the meaning of the relative asymmetry scores.

4) Research into the interior configuration of the house as opposed to neighborhood and community amenities could provide important information of the relative importance of each to individuals.

5) A very important area for further research is to answer the question raised in Chapter IV, that is; can we develop housing alternatives that are true alternatives given the strong social and design bias toward single family detached housing? Will our planning departments and current homeowners associations provide the zoning changes and neighborhood support needed to house the next generation of American families.

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APPENDICES

APPENDIX A

What follows here is a list of the qualitative features of single family detached housing as seen in Chapter II. In addition to the qualitative descriptions, an expected relative asymmetry (see also Appendix E) value range, based on the information presented here, is predicted for each room, concluding with a predicted room ranking. These are provided as an elaboration of the checklist developed for the annotated analysis. They help establish a qualitative basis for the quantitative analysis in Chapter IV. The following features of the single family detached house have been taken specifically from house studies by Rodgers (1962), Talcott, Helper and Wallach (1986), and Zeisel and Welch (1981), and are echoed throughout the vast popular literature on the single family detached house.

Features, Predicted Relative Asymmetry Values and Room Ranking for a Single Family Detached House

Entry. The entry of a house is a focal point (Talcott, Helper & Wallach, 1986). It should lead to the circulation areas to living, sleeping and service areas (Talcott, Helper & Wallach, 1986). There should be no direct view into any room form the entry (Talcott, Helper & Wallach, 1986). From this description it would be reasonable to assume that the entry would be a comparatively integrated space in relation to other spaces in the house. **The predicted relative asymmetry value will be less than 0.225.**

Living room. The living room is considered the heart of the home. Rodgers (1962) uses only restful words to describe the living room. The room should facilitate a variety of family activities

(Rodgers, 1962; Talcott, Helper & Wallach, 1986). The room should not be used as a pathway but should connect to the dining room and kitchen (Talcott, Helper & Wallach, 1986; Zeisel & Welch, 1981). The living room, like the entry, is also likely to register a relatively low (highly integrated) relative asymmetry score in relation to other major living spaces in the house. **The central nature of the living room will give it a predicted relative asymmetry score of between 0.150 and 0.300.**

Family room. The family room should serve as a second and less formal living room (Rodgers, 1962; Talcott, Helper & Wallach, 1986; Zeisel & Welch, 1981). This room is optional and, if it does exist in a house, should be adjacent to the living room but separated from it by walls (Rodgers, 1962). **This room is likely to be equally or more integrated than the living room due to its informal nature with a predicted relative asymmetry value of between 0.150 and 0.250.**

Kitchen. The kitchen should be easy to work in. It should be located close to the garage, front door, or other outdoor access (Rodgers, 1962; Talcott, Helper & Wallach, 1986). It should be directly accessible to the dining room (Rodgers, 1962; Talcott, Helper & Wallach, 1986; Zeisel & Welch, 1981). The literature generally does not describe the kitchen as needing to be near to major living areas to meet the needs of a nuclear family. Despite the call to locate the kitchen near to the entry and dining areas the kitchen is likely to rank high on the relative asymmetry scale due to a desire to shield the work area from other spaces in the house. **The predicted relative asymmetry values for the kitchen are between 0.300 and 0.600.**

Dining room. Dining areas should be adjacent to the kitchen and the living areas (Rodgers, 1962; Talcott, Helper & Wallach, 1986). **Because of a greater possible number of connections between the dining room and other rooms, the dining room is expected to be more integrated than the kitchen with predicted relative asymmetry values between 0.200 and 0.500.**

Bedroom. The bedroom is the most personal room in the house and should, therefore, be awarded some degree of privacy. It should be near to bathrooms and offer sufficient space for non-sleeping activities (Rodgers, 1962; Talcott, Helper & Wallach, 1986). The bedroom should be located away from the main living areas (Rodgers, 1962). Children's bedrooms should provide playspace (Zeisel & Welch, 1981). The privacy required for the bedrooms will earn them higher relative asymmetry. **The predicted relative asymmetry values will be greater than 0.400.**

Bathroom. Bathrooms should be near bedrooms (Rodgers, 1962; Talcott, Helper & Wallach, 1986). Rodgers (1962) recommends one and a half baths for a family, while Talcott, Helper and Wallach (1986) recommend two or more. Similar to the bedrooms, the bath will also register a relatively high relative asymmetry score. **The predicted relative asymmetry values will be greater than 0.400.**

Outdoor space. It is recommended that the primary outdoor space for a house be located at the back of the house to ensure maximum privacy (Rodgers, 1962). This space should be accessible from the kitchen and the living areas, yet secluded from the street (Talcott, Helper & Wallach, 1986). It is expected that the outdoor space will

have few connections to the interior living spaces and will be somewhat segregated. **The predicted relative asymmetry values will be between 0.250 and 0.600.**

The ranking of the rooms and their predicted relative asymmetry values are presented in Figure 41.

Predicted Relative Asymmetry Values and Room Ranking

Single Family Detached Housing

Room Ranking	Predicted Relative Asymmetry Values
Entry/ Circulation spaces	< .225
Family room	.125 to .250
Living room	.150 to .300
Dining room	.200 to .500
Outdoor space	.250 to .600
Kitchen	.300 to .600
Bedrooms/baths	> .400

Figure 41. Room ranking and predicted relative asymmetry values for a single family detached house.

The actual relative asymmetry values will vary for each plan examined. The ranking of the rooms, both as computed and as predicted will be of more importance for this research than the relative asymmetry values themselves. A further expectation for the single family detached house is that the overall range of the relative asymmetry values, form lowest to highest, will be large. This would indicate a clearer hierarchy between rooms than a small value range.

APPENDIX B

CHECK LIST FOR SINGLE FAMILY DETACHED HOUSE FLOOR PLAN ANNOTATED ANALYSIS

Entry

E-1 The entry is a focal point.
E-2 The entry leads to circulation to other areas of the house.
E-3 The entry offers no direct view into any room.

Hall

H-1 The hall provides access to all areas.

Living room

L-1 Traffic from the front door does not directly enter the living room.
L-2 The living room is not affected by street noise.
L-3 The bathroom is out of sight and sound from living room.
L-4 The living room connects to the dining room.
L-5 The living room is not used as a pathway.

Family room

F-1 The family room should be away from the sleeping areas.
F-2 The family room is separate from but near to the living room.
F-3 The family room is near the kitchen.
F-4 The family room is not used as a pathway.

Dining room

D-1 The dining room is adjacent to the living area.
D-2 The dining room is adjacent to the kitchen.
D-3 The dining room is between the living room and the kitchen.

Kitchen

K-1 The kitchen is near the dining room but able to be closed off from it.
K-2 The indoor play area is visible from kitchen.
K-3 The kitchen is near the service and garage areas.
K-4 The kitchen is near to a bathroom.
K-5 The kitchen is close to outdoor access.

Bathroom

Ba-1 the bathroom is near the bedrooms.
Ba-2 Bathroom noises are insulated from other spaces.
Ba-3 There are at least one and one half baths per house.
Ba-4 There is no view into an open bathroom door.

Bedroom

B-1 The bedroom opens into a hall.
B-2 The bedroom is large enough to accommodate living spaces.
B-3 The bedroom is in a quiet area.

B-4 The bedroom is private.
B-5 The bedroom is near a bathroom.
B-6 The bedroom is away from major living areas.

Outdoor space
O-1 The primary outdoor spaces are at the back of the house.
O-2 There is easy access to the house.
O-3 The outdoor areas are secluded from the street.

APPENDIX C

What follows here is a list of the qualitative features of housing for single parent families as seen in Chapter II. In addition to the qualitative descriptions, an expected relative asymmetry (see also Appendix E) value range, based on the information presented here, is predicted for each room, concluding with a predicted room ranking. These are provided as an elaboration of the checklist developed for the annotated analysis. They help establish a qualitative basis for the quantitative analysis in Chapter IV. All of the following material in single parent family housing is based on the research of Cook, et al. (1988).

Features, Predicted Relative Asymmetry Values and Room Ranking for a Single Parent Family Dwelling

Entry. Each unit should have its own entry that is clearly articulated. The entry should have a direct connection to the outdoors (if possible), immediate access to artificial lighting controls, access to the living room, proximity to circulation paths, and no visual connection to bedrooms or bathroom. This space is described as the "hub" of the single parent dwelling and would be expected to be fairly integrated. **The predicted relative asymmetry value will be less than 0.150.**

Living room. Living rooms should be close to the main entry, be able to accommodate a variety of furniture and activities, and have direct access to the outdoors. While the description of the living room is somewhat sparse, information form other rooms suggests it

would be a highly integrated space. **The predicted relative asymmetry values would be between 0.150 and 0.300.**

Kitchen/Dining. Kitchen areas should be large to accommodate children's needs as well as adults working in the area. The kitchen and dining room as one space is preferred. These spaces are often described in plans of prototype single parent family dwellings as central spaces (Franck & Ahrentzen, 1989). **The predicted relative asymmetry values will be between 0.200 and 0.400.**

Bedrooms. Bedrooms should be located away from the living areas to maximize privacy. These are best if arranged around a short corridor for ease of parental monitoring, and be either large enough to serve as play areas in the individual unit or have access to a space that can serve as a play area. Adult bedrooms should be private enough for activities other than sleeping. The privacy needs of bedrooms would tend to segregate these spaces. **The predicted relative asymmetry values will be 0.350 or greater.**

Bathroom. Bathrooms should be located close to bedrooms and offer access from living areas as well. Due to their general proximity to bedrooms the bathrooms would also be expected to be fairly segregated. **The predicted relative asymmetry values will be 0.350 or greater.**

Private outdoor space. Whenever possible each unit should have access to private outdoor space. This should be close to the main living areas, have ground level access (no steps), and provide fencing to control small children. Private outdoor space is absent from most single parent dwellings due to cost. However where it does occur it

is expected to integrate with the living spaces and be separate from the sleeping areas. **The predicted relative asymmetry values will be between 0.300 and 0.500.**

The ranking of the rooms and their predicted relative asymmetry values are presented in Figure 42.

Single Parent Family Housing

Room Ranking Values	Predicted Relative Asymmetry
Entry/ Circulation spaces	< .150
Living room	.150 to .300
Kitchen/ Dining room	.200 to .400
Outdoor space	.300 to .500
Bedrooms/Baths	> .350

Figure 42. Room ranking and predicted relative asymmetry values for a single parent family dwelling.

The actual relative asymmetry values will vary for each plan examined. The ranking of the rooms, both as computed and as predicted will be of more importance for this research than the relative asymmetry values themselves. A further expectation for the single parent family dwelling is that the overall range of the relative asymmetry values, form lowest to highest, will be small. This would indicate an attempt by designers to integrate work and home life; a need clearly stated in the research on this family type (Franck & Ahrentzen, 1989).

APPENDIX D

CHECKLIST FOR SINGLE PARENT FAMILY HOUSING ANNOTATED ANALYSIS

Entry

E-1 The entry is clearly articulated.
E-2 The entry has a direct connection to the outdoors.
E-3 The entry has immediate access to the living room.
E-4 The entry has access to all circulation paths.
E-5 The entry does not provide visual access to bedrooms or baths.
E-6 The entry has space to dress children for outdoor play.

Living room

L-1 The living room is close to the entry.
L-2 The living room has direct access to the outdoors.
L-5 The living room has natural light and ventilation.

Dining room

D-1 The kitchen and the dining room as one space is preferred.
D-2 The dining room is adjacent to the kitchen.

Kitchen

K-1 The kitchen and dining room as one space is preferred.
K-2 The kitchen is large.
K-3 The kitchen has direct access to the outdoors.

Bathroom

Ba-1 The bathroom is close to bedrooms.
Ba-2 The bathroom is easily accessed from the living areas.

Bedroom

B-1 The bedroom is private.
B-2 The bedroom is away from the living areas.
B-3 The bedroom is arranged around a short hallway.
B-4 The bedroom is easily monitored by the parent.
B-5 The bedroom is large enough to serve as play areas.
B-6 The bedroom has ample storage or closet space.

Stairs within units

St-1 U-shaped stairs are preferred for safety.

Outdoor space

O-1 Each unit should have direct access to the outdoors where possible.
O-2 Outdoor access is close to the living areas.
O-3 Ground level access (no steps) is preferred.
O-4 Provide private decks where ground level access is impossible.

APPENDIX E

Gamma Analysis Described

Gamma analysis involves examining the syntax of interior spaces. The method allows for an analysis and comparison of buildings in terms of how categories of space are related and arranged, and how the building works as an interface between inhabitants and visitors. The building can be described as having two basic properties: the boundary of the house, the perimeter that separates the house from the exterior world; and the interior permeability, the juxtaposition that ensures that every part of the house is accessible from every other part. Gamma analysis is the analysis of these two basic spatial relations and controls.

Gamma Maps

Gamma analysis transforms the floor plan into gamma maps (Hillier & Hanson, 1984), with every interior space represented as a circle, and its relations of permeability represented by a line. In other words each room or space becomes a circle and every entrance and exit or connection of that room to another or to the outside of the building becomes a line, as illustrated below in Figure 43.

The carrier for the gamma map is the space that is to be considered as the point of reference. It is the abstract space that defines the location of the object of analysis. The carrier for the entire building is the space outside of the building. The carrier is redefined for computation purposes as each interior space is analyzed and as each interior space becomes the object of analysis. The carrier allows a point of reference to exist for each interior space

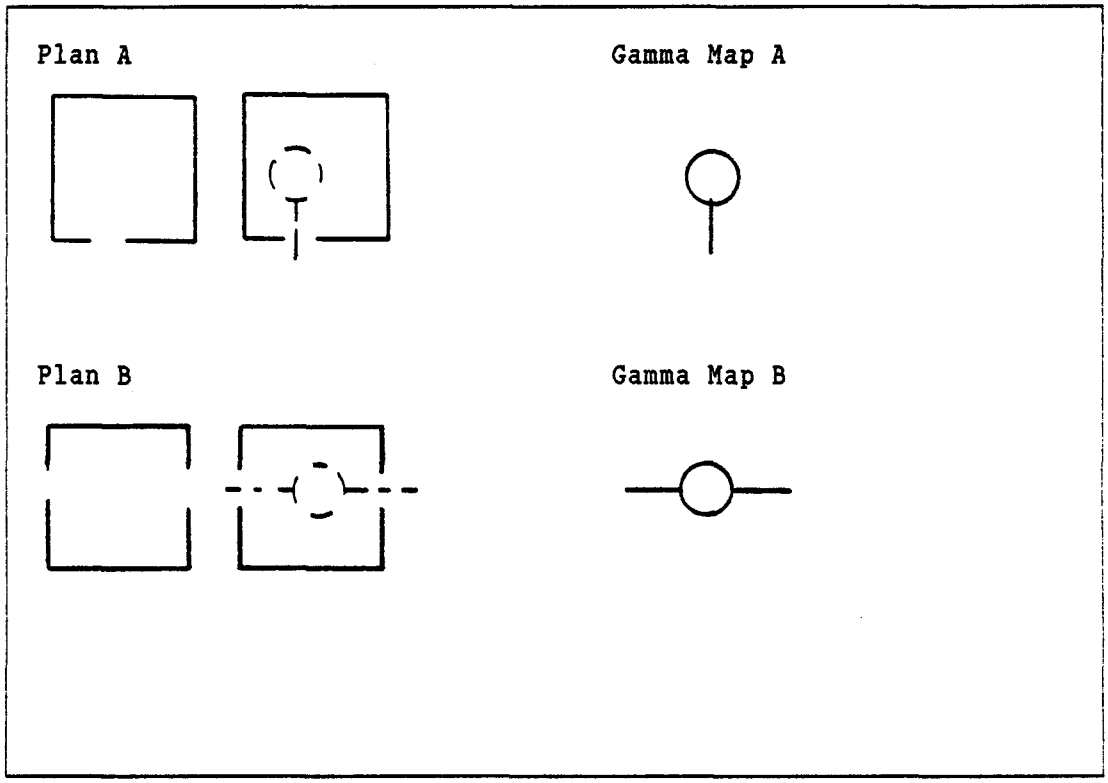


Figure 43. The generation of a gamma map. Adapted from The Social Logic of Space by Hillier & Hanson, 1984, New York: Cambridge University Press.

as well as for the entire building. The carrier is represented on a gamma map as a circle with a cross inside, as illustrated below in Figure 44.

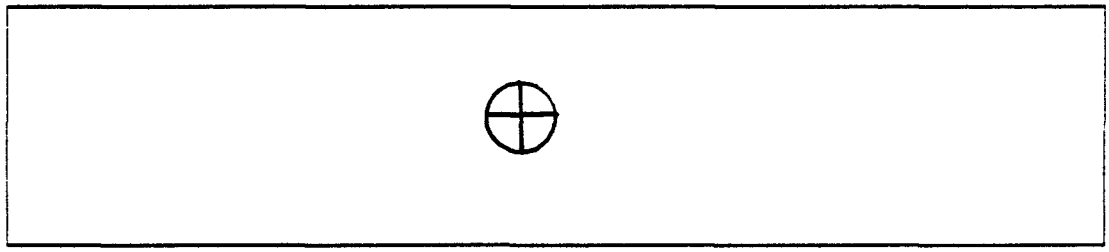


Figure 44. The Carrier of the System. Adapted form The Social Logic of Space, by Hillier & Hanson, 1984, New York: Cambridge University Press.

The carrier is used to help determine the measure of integration or segregation for the interior spaces as well as for the building as a

whole. When the carrier is added to the gamma maps in Figure 43, they will become those in Figure 45.

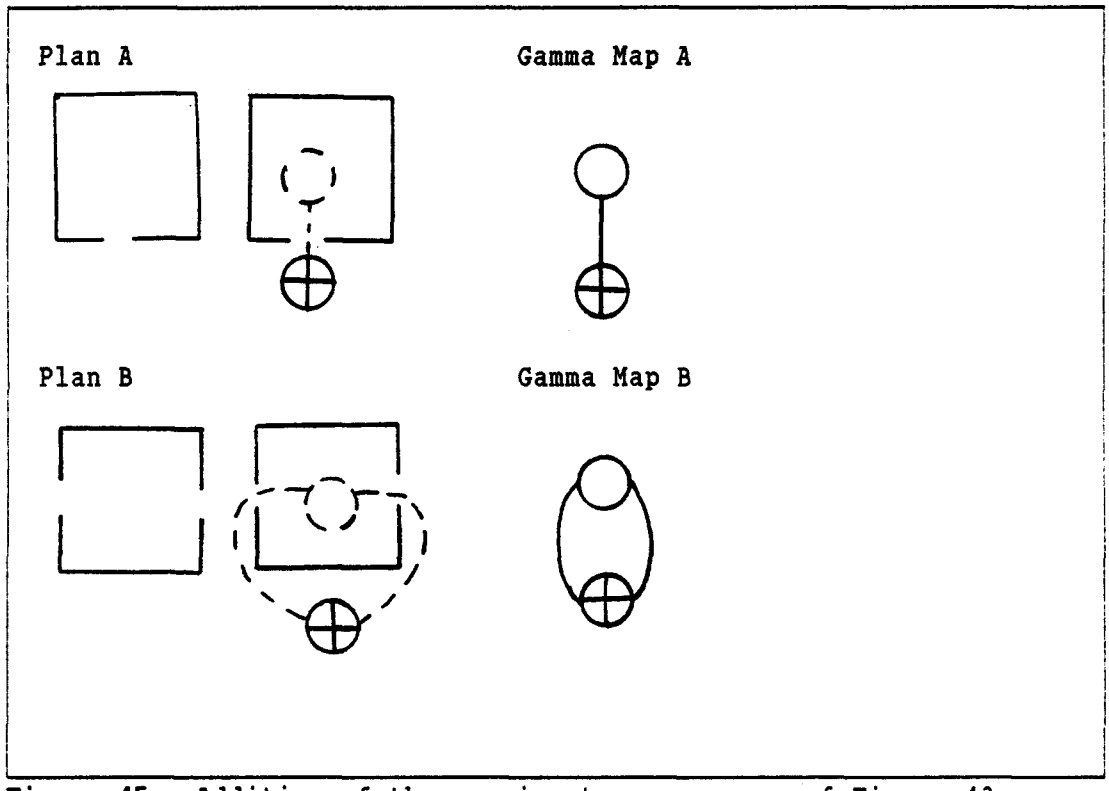


Figure 45. Addition of the carrier to gamma maps of Figure 43. Adapted from The Social Logic of Space by Hillier & Hanson, 1984, New York: Cambridge University Press.

Using these general configuration generators patterns can be discerned with the properties of symmetry, asymmetry, distributedness, and nondistributedness. Symmetry and asymmetry are concerned with the measure of the depth of a space within a building. A space or series of spaces will have a symmetric relationship if, as illustrated in Figure 46, the relationship of space (b) to space (c) is the same as the relationship of space (c) to space (b).

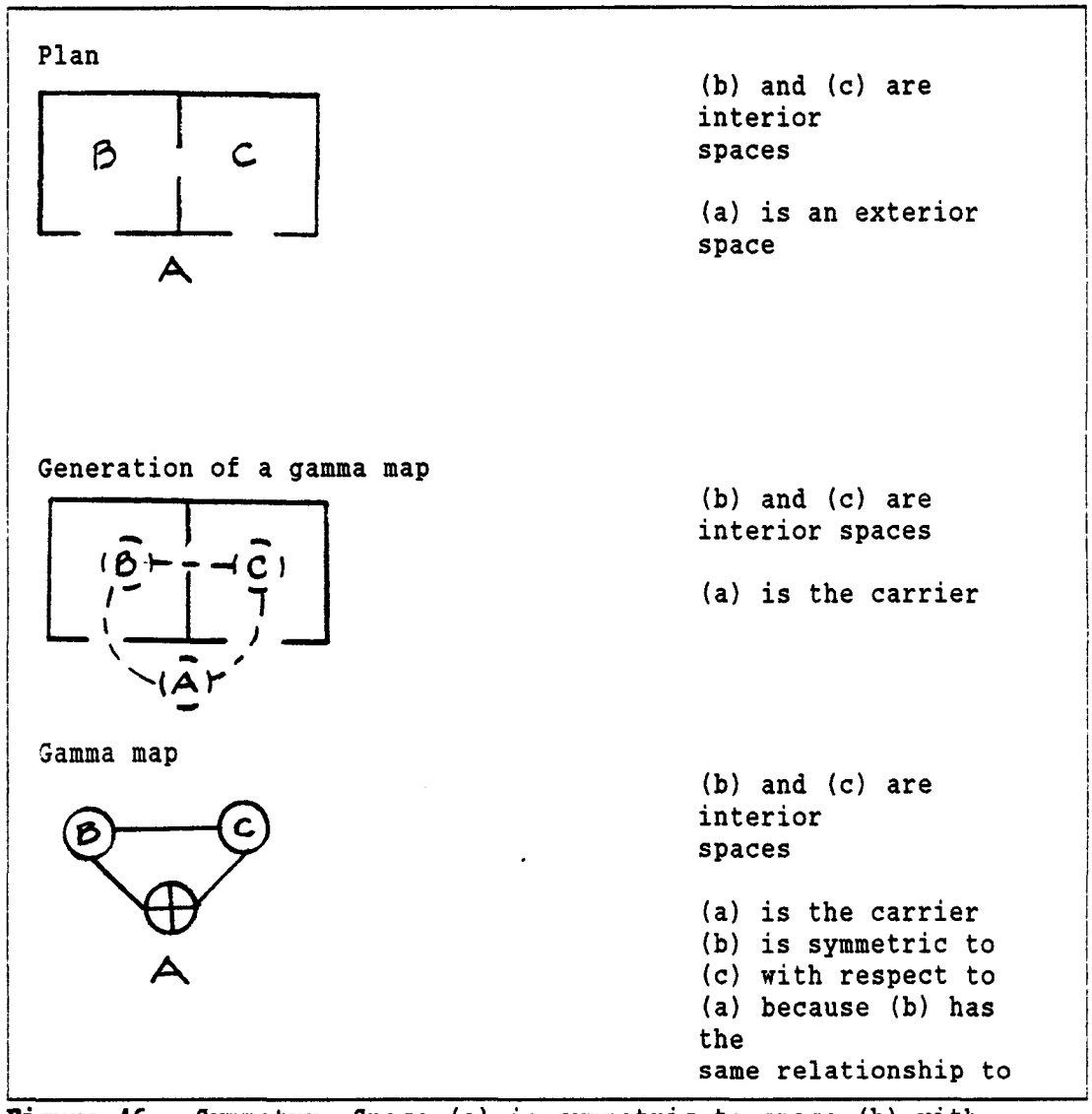


Figure 46. Symmetry. Space (a) is symmetric to space (b) with respect to space (c). Adapted from The Social Logic of Space (p. 148) by Hillier & Hanson, 1984, New York: Cambridge University Press.

A symmetric relation of space will indicate a tendency toward integration of social categories. All symmetric spaces will be the same distance, or depth, measured as minimum number of spaces to get from the point of reference or carrier to the given space. In Figure

46, both space (b) and space (c) are at a depth of one from space (a), the carrier. The notion of depth is illustrated in Figure 47.

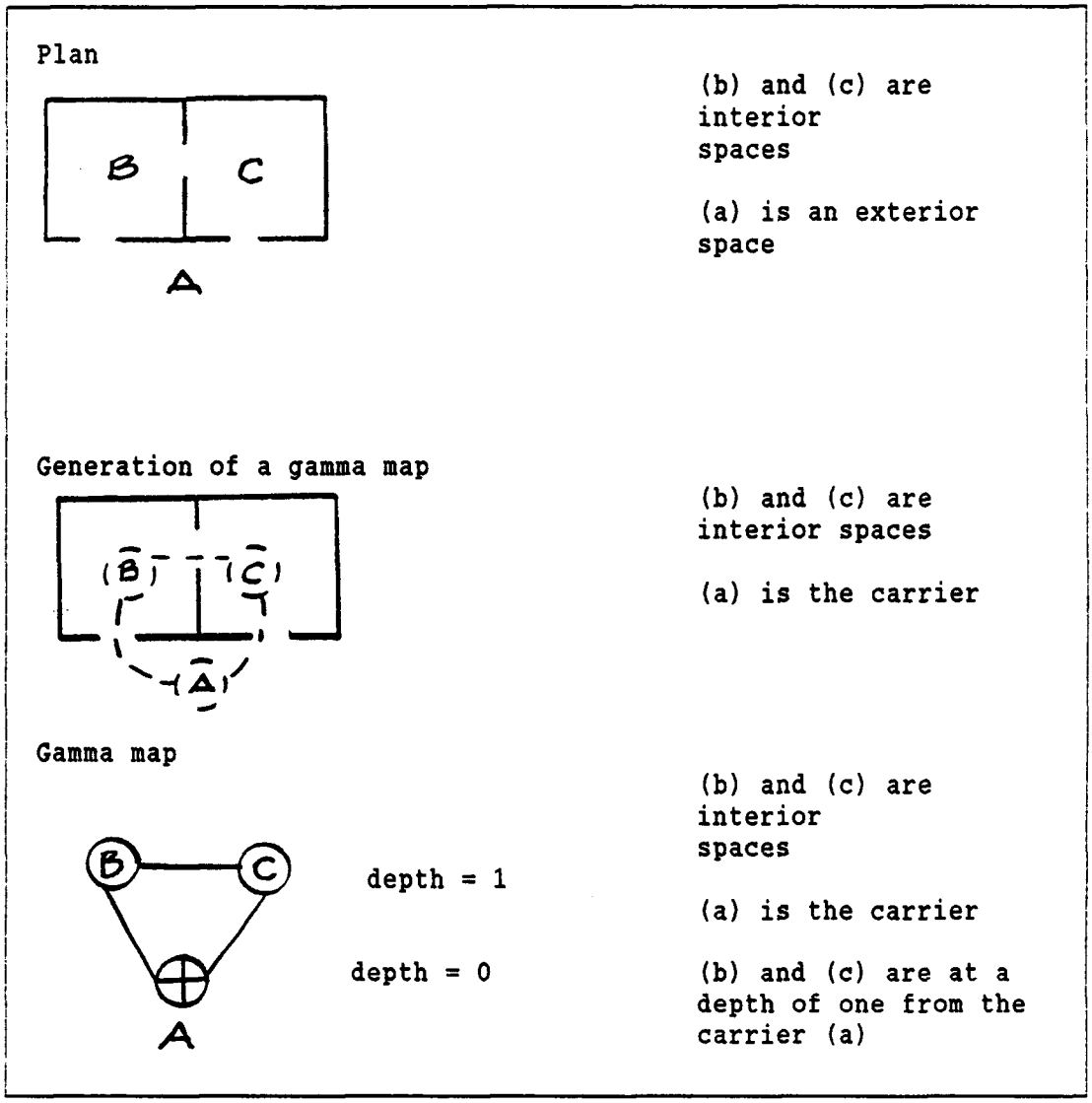


Figure 47. Depth of the symmetric spaces (b) and (c) of Figure 10, as measured from the carrier (a). Adapted from The Social Logic of Space (p. 148) by Hillier & Hanson, 1984, New York: Cambridge University Press.

An asymmetric relation also involves the notion of depth. An asymmetric relationship tends to be more linear, insuring a depth measure for each space, as illustrated in Figure 48.

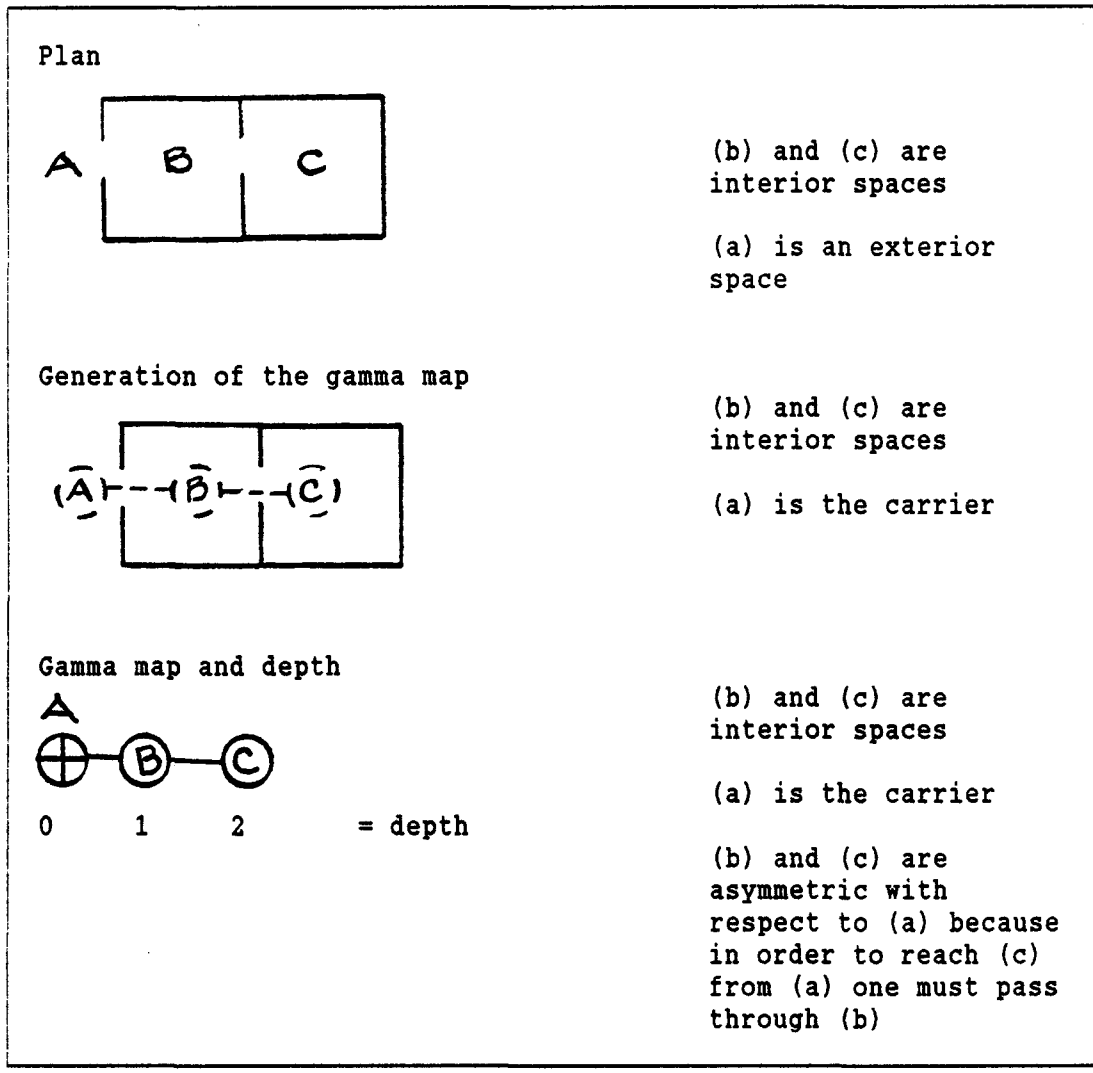


Figure 48. Asymmetry and depth. In order to reach space (c) from space (a), one must pass through space (b). Adapted from The Social Logic of Space (p. 148) by Hillier & Hanson, 1984, New York: Cambridge University Press.

An asymmetric relationship of spaces will require the passage through one space in order to reach another. In Figure 48, one must pass through space (b) from space (a) (the carrier) in order to reach space (c). With space (a) as the carrier, space (b) has a depth of one and space (c) has a depth of two. An asymmetric relation of space

will indicate a more segregated spatial arrangement and a tendency toward segregation of social categories.

Distributedness and nondistributedness are concerned with the number of connections between spaces. A distributed relationship will have more than one non-intersecting connection between spaces and will diffuse spatial control. This is illustrated in Figure 49.

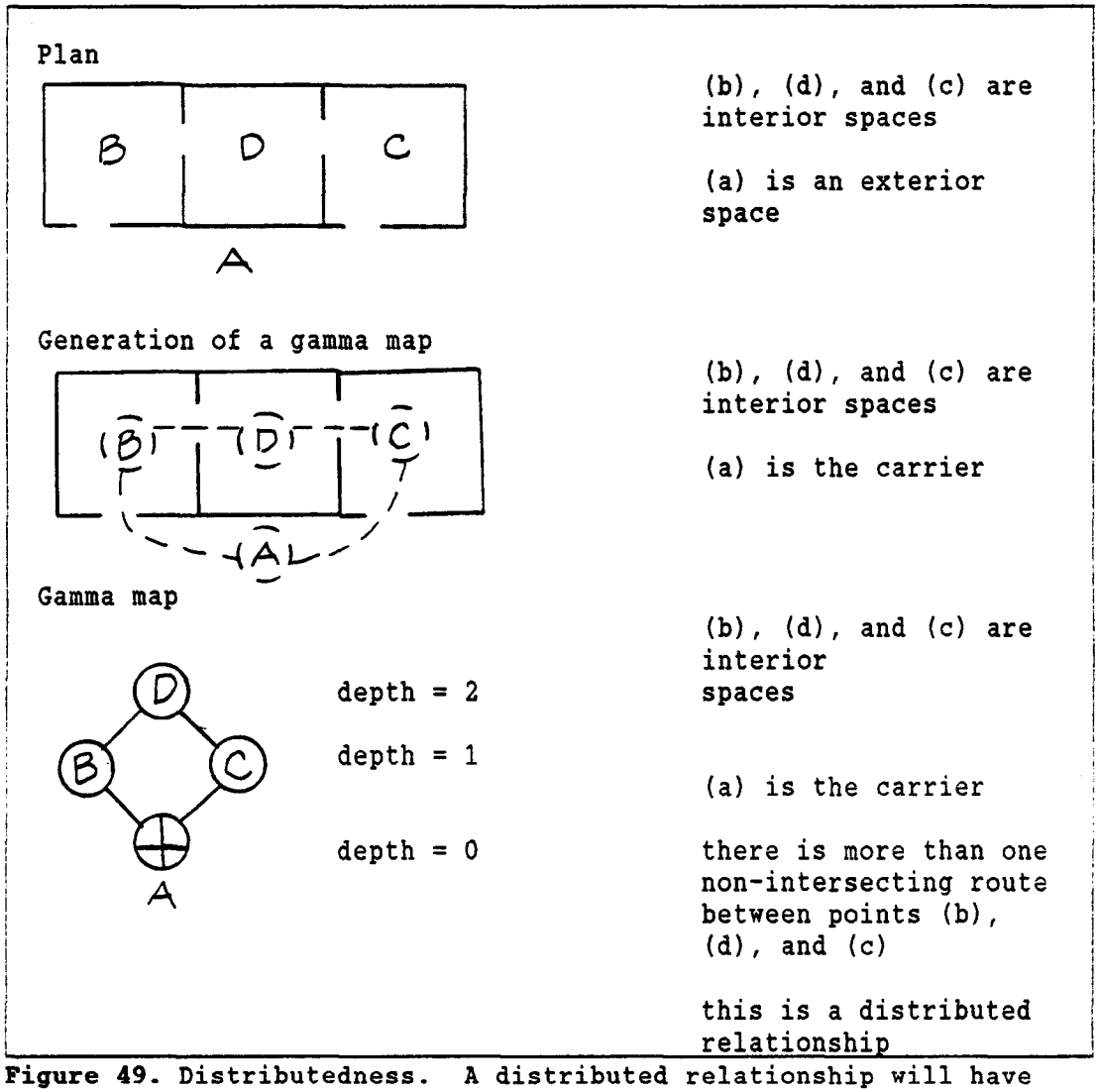


Figure 49. Distributedness. A distributed relationship will have more than one non-intersecting route between spaces. Adapted from The Social Logic of Space, (p. 148) by Hillier & Hanson, 1984, new York: Cambridge University Press.

A nondistributed relationship, as shown in Figure 50, will have only one connection between spaces and will tend toward more centralized spatial control.

Each of these properties measures integration or segregation of the building through a mathematical formula based on the spaces

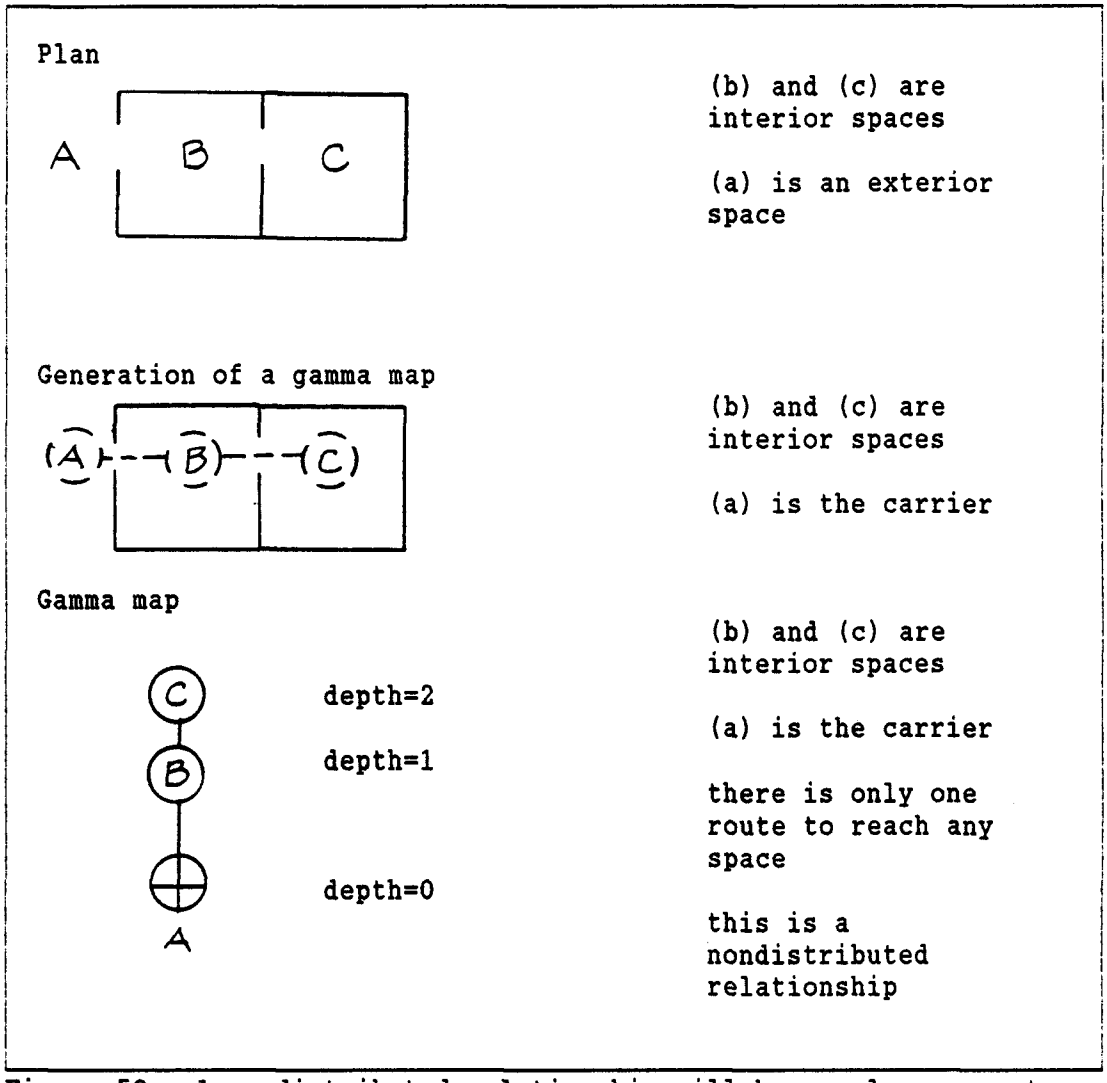


Figure 50. A nondistributed relationship will have only one route from space (b) to space (a) and space (b) to space (c). Adapted from The Social Logic of Space (p. 148) by Hillier & Hanson, 1984, New York: Cambridge University Press.

present in the floor plan. The basic representation of these properties in combination is illustrated on the plans that follow (Figures 51, 52,& 53).

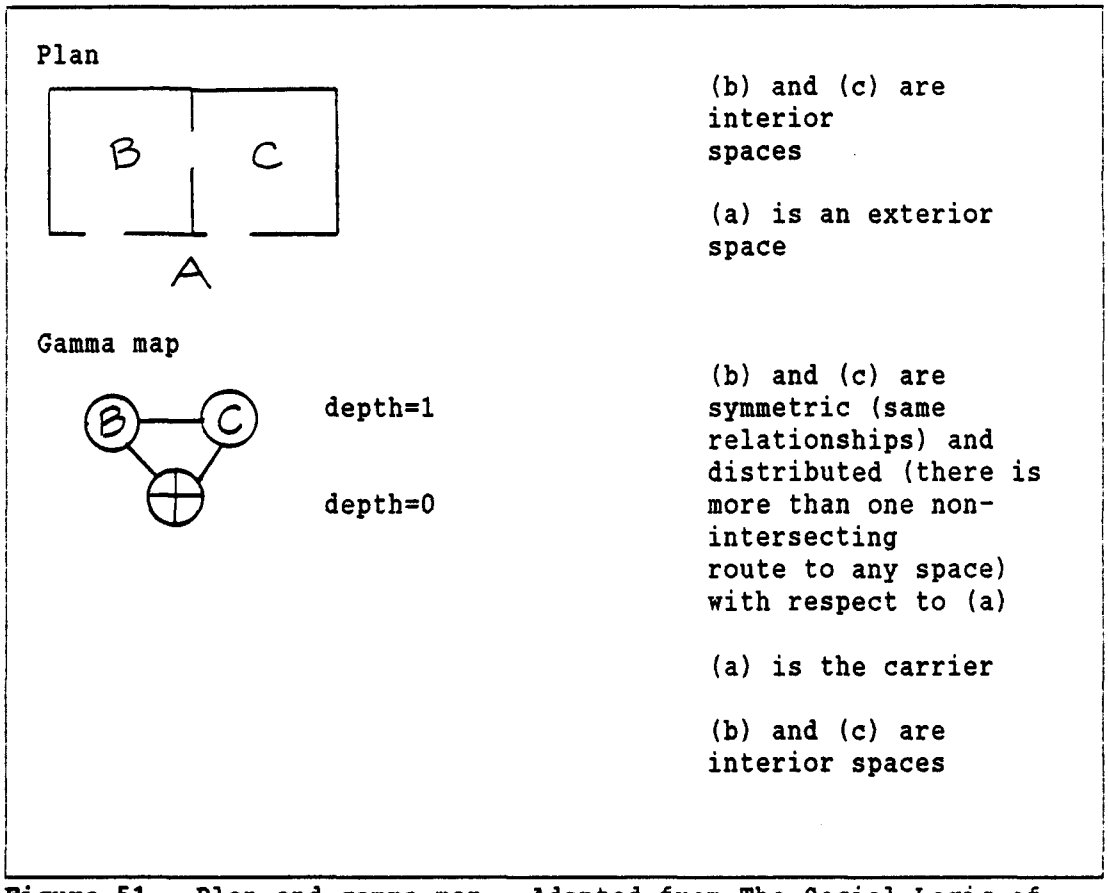


Figure 51. Plan and gamma map. Adapted from The Social Logic of Space (p.148) by Hillier & Hanson, 1984, New York: Cambridge University Press.

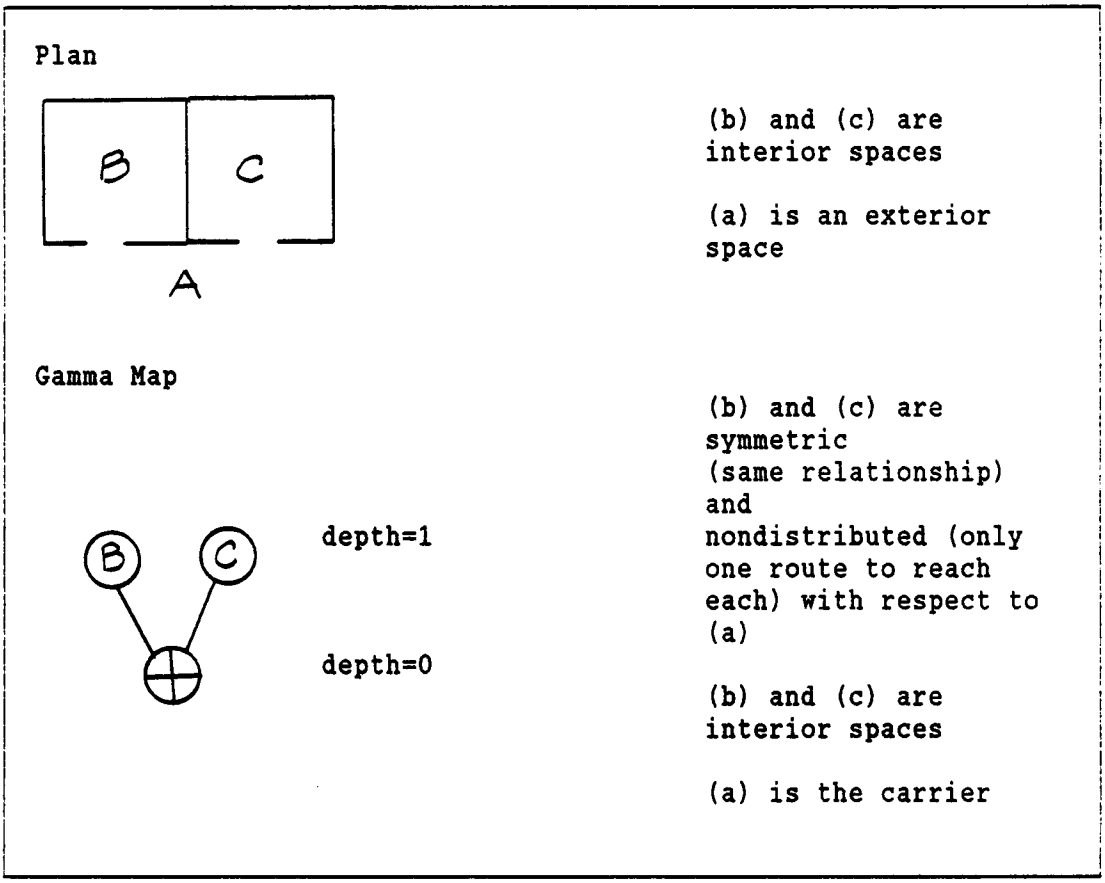


Figure 52. Plan and gamma map. Adapted from The Social Logic of Space (p. 148) by Hillier & Hanson, 1984, New York: Cambridge University Press.

Figures 54 and 55, and 56 and 57, illustrate some more complex relations between spaces that warrant a more careful description. Figure 54 illustrates a plan with two entries and a center space, accompanied by its gamma map.

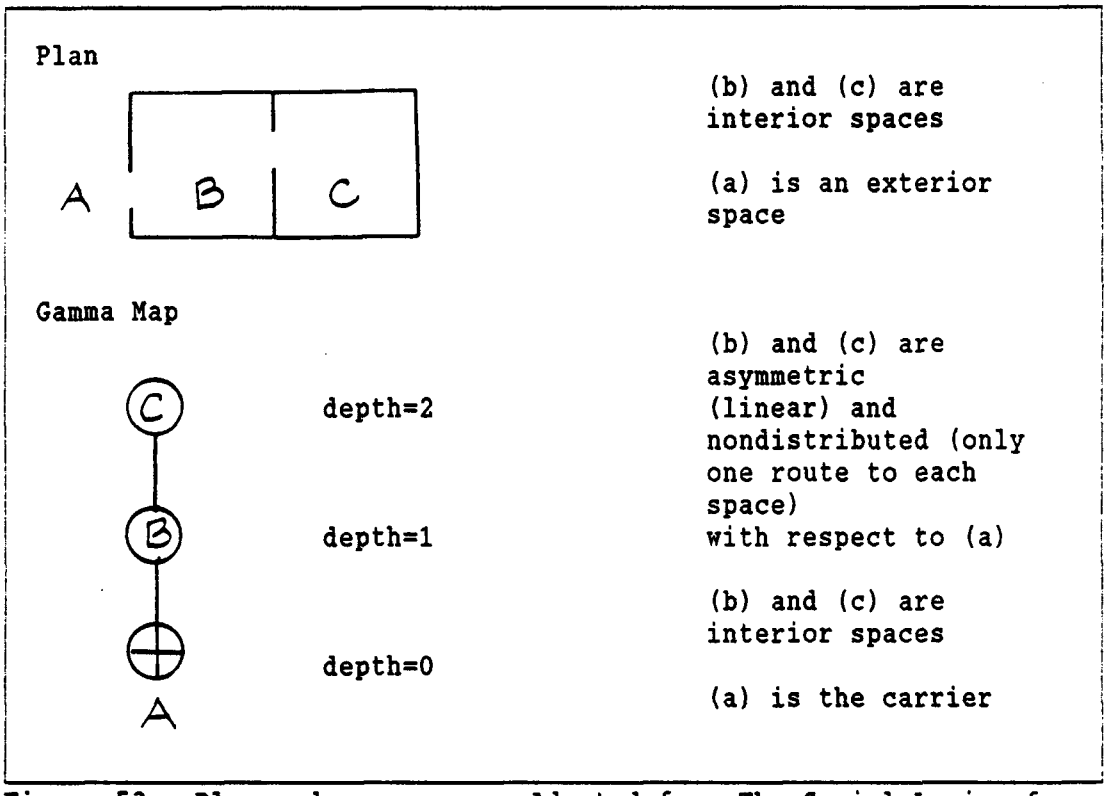


Figure 53. Plan and gamma map. Adapted from The Social Logic of Space (p.148) by Hillier & Hanson, 1984, New York: Cambridge University Press.

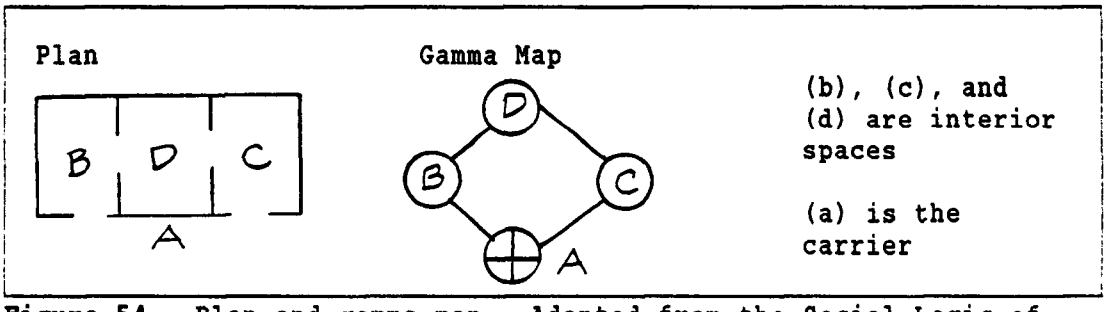


Figure 54. Plan and gamma map. Adapted from the Social Logic of Space (p.148) by Hillier & Hanson, 1984, New York: Cambridge University Press.

This gamma map was generated as described in Figure 55.

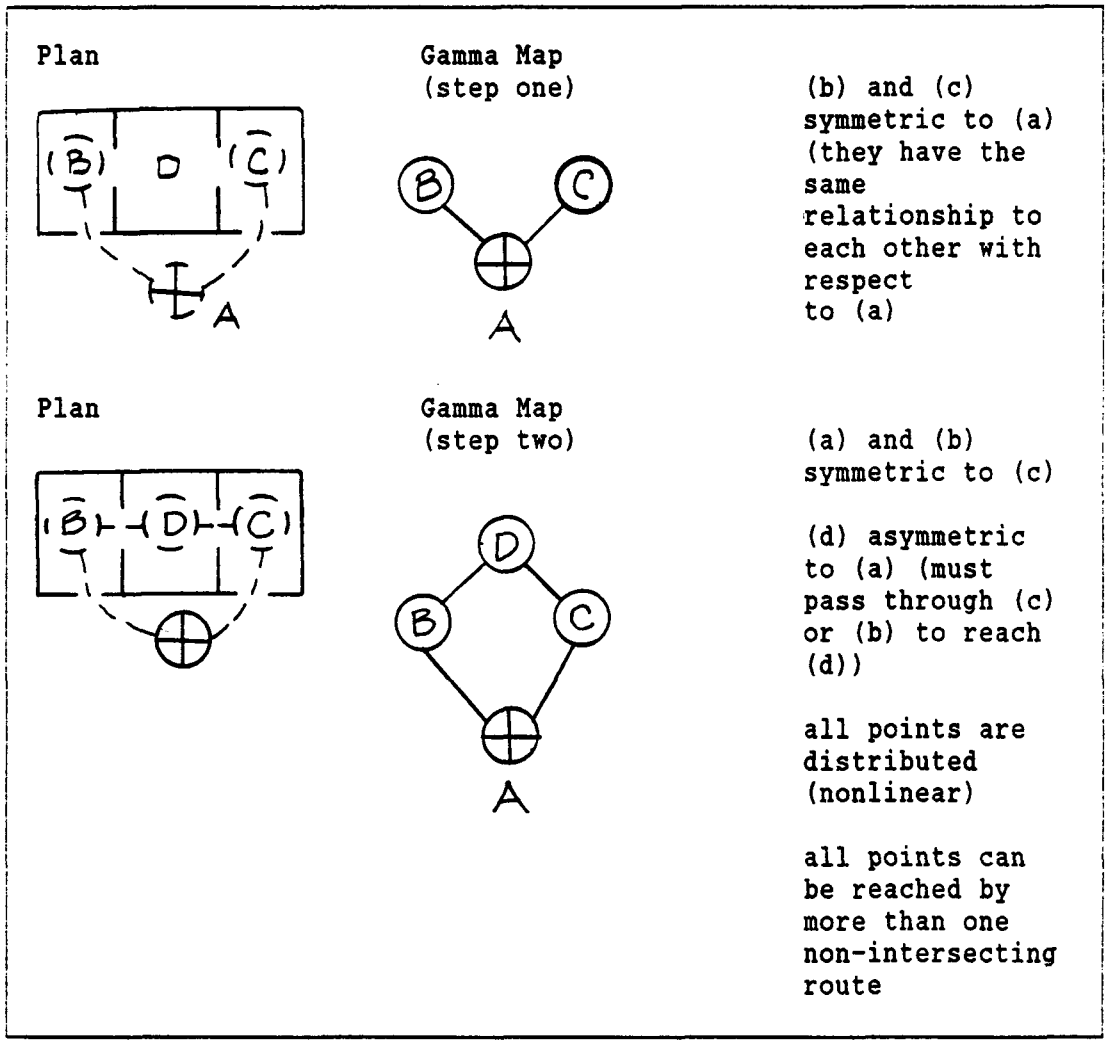


Figure 55. Generation of the gamma map. Adapted from The Social Logic of Space (p.148) by Hillier & Hanson, 1984, New York: Cambridge University Press.

Figures 56 and 57 illustrate a variation of the plan used in Figures 54 and 55. In this case the change in the plan involves changing the permeability of the interior spaces.

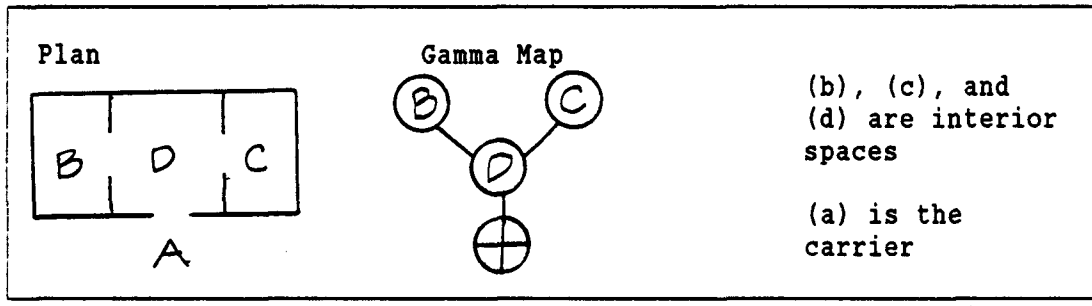


Figure 56. Plan and gamma map. Adapted from the Social Logic of Space (p.149) by Hillier & Hanson, 1984, New York: Cambridge University Press.

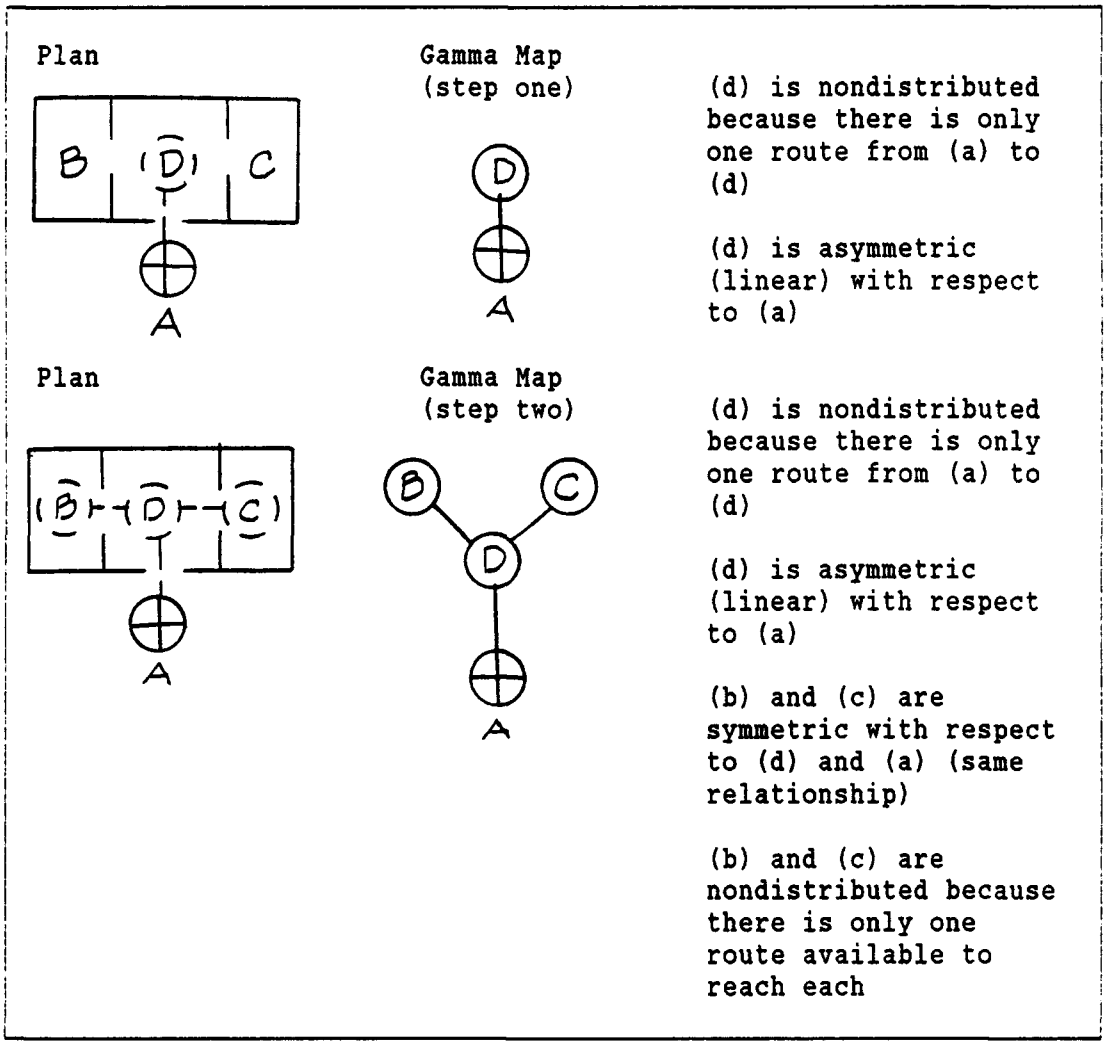


Figure 57. Generation of the gamma map. Adapted from The Social Logic of Space (p.149) by Hillier & Hanson, 1984, New York: Cambridge University Press.

Justified Gamma Maps

These patterns provide the basic dimensions of the model needed to construct the gamma maps of interior floor plans. The next step to this construction is to establish a justified gamma map. A justified gamma map is constructed and defined by assigning every space a depth value according to the distance it is from the carrier. Distance is

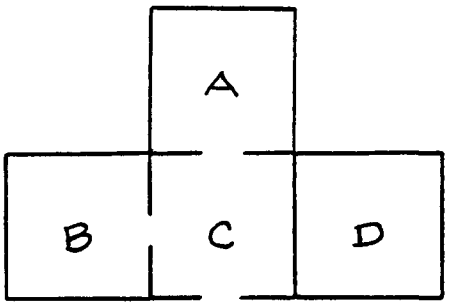
not measured in feet and inches but rather in the minimum number of spaces from the carrier. The spaces are still represented as circles connected with lines. All spaces that are the same depth from the carrier are lined up horizontally above the carrier, with lines representing the direct connections to other spaces drawn in as needed. Justified gamma maps allow for the properties of symmetry, asymmetry, distributedness, and nondistributedness to become easier to see than in the plan itself. These maps also permit quantitative measurement of these properties. The most important measurement in this analysis will be relative asymmetry (RA), measuring the symmetry - asymmetry dimension of the space. The relative asymmetry compares how deep a space is from a particular point, usually the carrier of the system. Relative asymmetry is found in the following manner:

$$RA = \frac{2(MD - 1)}{k-2}$$

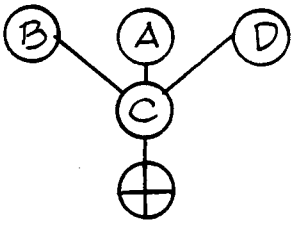
where MD = mean depth of the space, found by adding all of the depth measurements for the building together and dividing by the number of spaces minus one (the space being analyzed), and k = the number of spaces in the system. Relative asymmetry is the measure of integration of the space. The mean relative asymmetry measures the integration of the entire system. Low RA values indicate a high degree of integration, and high values indicate a low degree of integration or a high degree of segregation of spaces. The more symmetric, or the lower the RA value, the more the space will be socially integrated.

Ringiness and Space Link Ratio

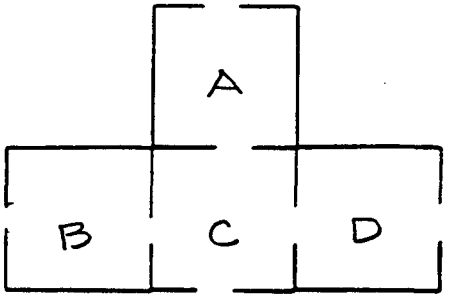
A second measure is of relative ringiness. This measure looks at the number of alternate routes between spaces in a building. Rings will occur when the number of connections between (k) number of spaces is (k) or greater (Hillier & Hanson, 1984). This is illustrated in Figure 58.



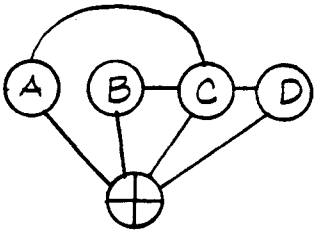
Space link ratio = 1.0



No rings.



Space link ratio = 1.4



Rings: +,A,C; +,B,C; +,B,C,D; +,C,D

Figure 58. Ringiness and Space Link Ratio.

The measure of ringiness is of less importance for the analysis to be preformed here. Instead of an elaborate ringiness measure, the space link ratio (Hillier, Hanson, & Graham, 1987) will be presented.

The space link ratio, like relative symmetry (RA) values, is examined in comparison to discern meaning. The space link ratio is determined by dividing the number of spaces (rooms) and the number of connections between rooms plus one.

$$\frac{\text{Number of connections between rooms + 1}}{\text{Number of rooms}}$$

In general, buildings with a greater space link ratio will be more "ringy", or have more options for routes between spaces than those buildings with smaller space link ratio values. A space with no rings will have a space link ratio of one.

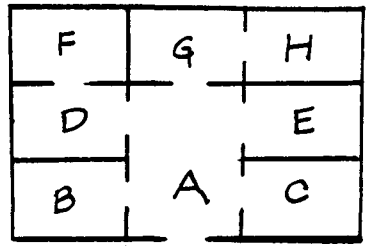
A discussion of the number of connections between spaces and the nature of those connections will be part of the annotated analysis. The more distributed the system, or the greater the space link ratio, the more diffused will be the spatial control. The less distributed, that is the lower the value of the space link ratio, the more centralized will be the spatial control.

Example of Gamma Analysis Technique

The basic proposition of gamma analysis is that buildings transmit social information through their layout and floor plan, both through variations in these and through the examination of these from different constituent spaces. Spatial labels are important in gamma analysis, what a room is called and how it is generally used become important indicators when examining the relative asymmetry of the

space. An example of this analysis method follows. This analysis is taken from Hillier and Hanson (1984) intact as a means of illustrating gamma analysis. Figures 59 and 60 show the plans of two theoretical buildings with similar geometries and room juxtapositions. The diagram includes a justified gamma map for each, as well as a table of the relative asymmetry (RA) for the spaces.

Plan A



Gamma Map

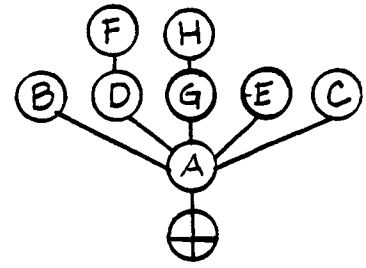


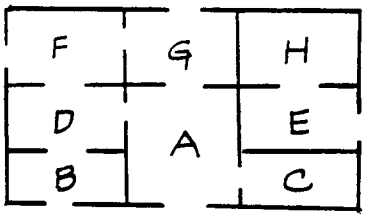
Table of Relative Asymmetry (RA) Values

Space	Depth as point of reference changes									MD	RA value
	+	a	b	c	d	e	f	g	h		
+	0	1	2	2	2	2	3	2	3	2.125	.321
a	1	0	1	1	1	1	2	1	2	1.250	.071
b	2	1	0	2	2	2	3	2	3	2.125	.321
c	2	1	2	0	2	2	3	2	3	2.125	.321
d	2	1	2	2	0	2	1	2	3	1.875	.250
e	2	1	2	2	2	0	3	2	3	2.125	.321
f	3	2	3	3	1	3	0	3	4	2.750	.500
g	2	1	2	2	2	2	3	0	1	1.875	.250
h	3	2	3	3	3	3	4	1	0	2.750	.500
									Mean RA value		.317

k = number of spaces = 9
MD = mean depth = total depth/(k-1)
RA = relative asymmetry = 2(MD-1)/(k-2)
Values are determined by summing the depths of each space from the point of reference (carrier) and dividing by the number of spaces minus one. Using the exterior space as the carrier:
k = the number of spaces in the building = 9
sum of the depths = 17 (0 + 1 + 2 + 2 + 2 + 2 + 3 + 2 + 3 = 17)
Mean depth = MD = sum of the depths/(k-1) = 17/8 = 2.125
Relative asymmetry = RA = 2(MD - 1)/(k-2)
2(2.125 -1)/(9-2) = .321

Figure 59. Plan, gamma map, and table of RA values. Adapted from The Social Logic of Space (pp. 150-152) by Hillier and Hanson, 1984, New York: Cambridge University Press.

Plan B



Gamma Map

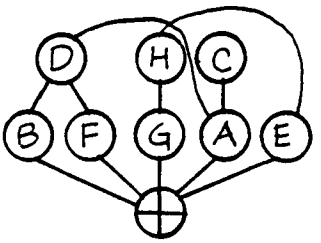


Table of Relative Asymmetry (RA) Values

Space	Depth as point of reference changes									MD	RA value
	+	a	b	c	d	e	f	g	h		
+	0	1	1	1	1	1	2	2	2	1.375	.107
a	1	0	1	2	2	2	1	2	3	1.750	.214
b	1	1	0	2	1	2	2	1	2	1.500	.143
c	1	2	2	0	2	2	3	1	1	1.750	.214
d	1	2	1	2	0	2	1	2	1	1.500	.143
e	1	2	2	2	2	0	1	3	3	2.000	.286
f	2	1	2	3	1	1	0	3	2	1.875	.250
g	2	2	1	1	2	3	3	0	2	2.000	.286
h	2	3	2	1	1	3	2	2	0	2.000	.286
									Mean RA value		.202

k = number of spaces = 9
MD = mean depth = total depth/(k-1)
RA = relative asymmetry = 2(MD-1)/(k-2)
Values are determined by summing the depths of each space from the point of reference (carrier) and dividing by the number of spaces minus one. Using the exterior space as the carrier:
k = the number of spaces in the building = 9
sum of the depths = 11 (0 + 1 + 1 + 1 + 1 + 1 + 2 + 2 + 2 = 11)
Mean depth = MD = sum of the depths/(k-1) = 11/8 = 1.375
Relative asymmetry = RA = 2(MD - 1)/(k-2)
2(1.375 -1)/(9-2) = .107

Figure 60. Plan, gamma map, and relative asymmetry values. Adapted from The Social Logic of Space (pp. 150-152) by Hillier and Hanson, 1984, New York: Cambridge University Press.

The relative asymmetry (RA) table is designed to demonstrate the generation of the relative asymmetry values for each interior space as well as the building as a whole. The integration measure for the entire building is the RA value obtained by using the outside of the building as the carrier or point of reference. As each interior space is analyzed they become, in turn, the carrier and the depth values change accordingly, as indicated in Figures 59 and 60. The RA values obtained indicate the integration or segregation of each space from the rest of the building.

The comparison of the two theoretical buildings indicates that despite the seeming similarity in the plans the two building have very different relative asymmetry (RA) values, the building described by plan B, Figure 60, (mean RA=.202) being much more integrated overall than the building described by plan A, Figure 59, (mean RA=.317). Plan B is also more distributed than plan A as can be seen by the rings formed in plan B that are absent in plan A. These rings indicate more connections between spaces and a more diffuse form of control of those spaces.

Example of Gamma Analysis and Social Analysis

Hillier and Hanson (1984) offer a comparison of a typical English cottage as originally designed in the nineteenth century and as transformed in the twentieth century. This comparison is reproduced here (Figure 61) as a means of example of the method as it applies to social orientation.

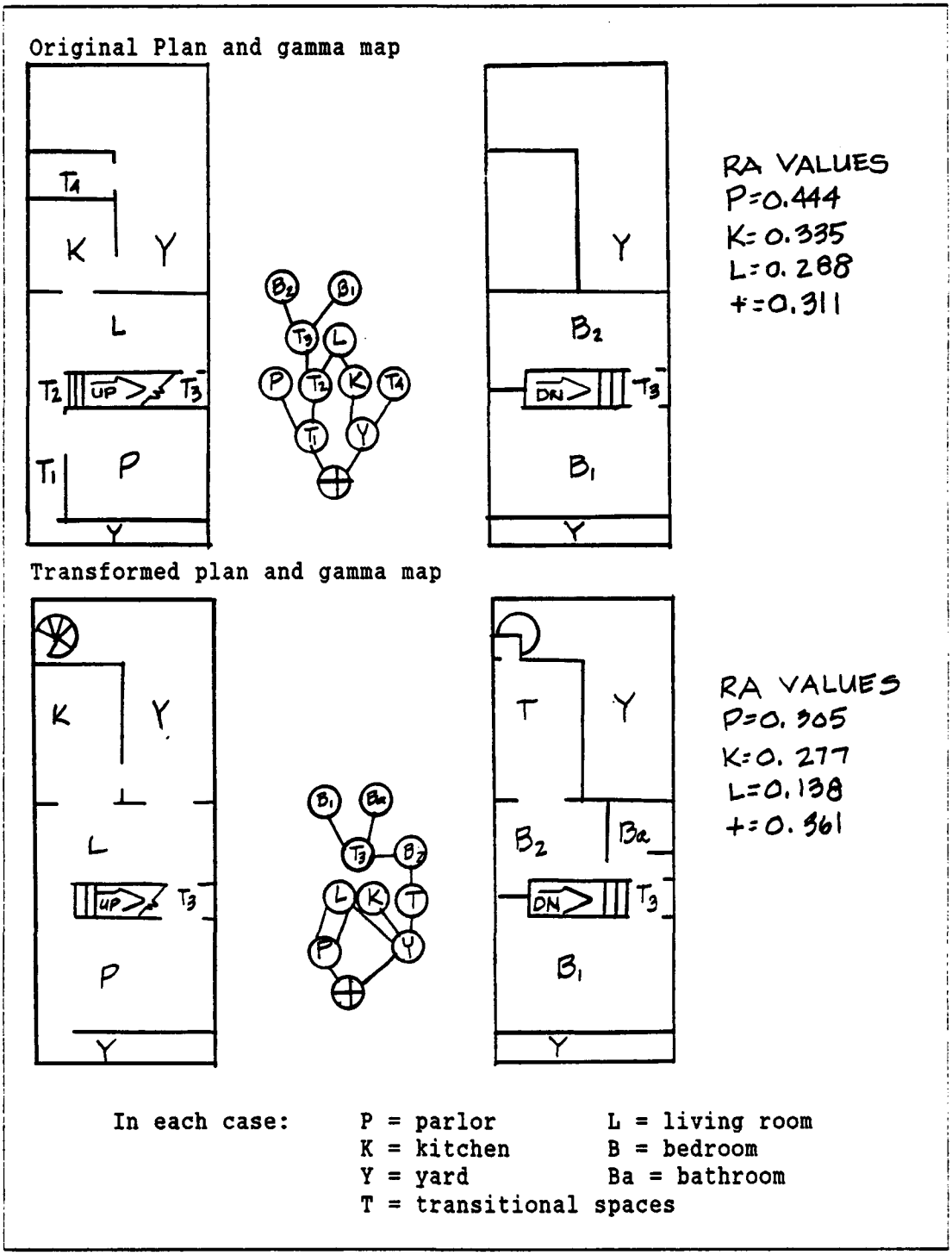


Figure 61. A typical English cottage as built in the nineteenth century and as recently remodeled. Adapted from The Social Logic of Space (p. 156) by Hillier and Hanson, 1984, New York: Cambridge University Press.

The original house plan reflects traditional English house layout (Hillier & Hanson, 1984). The ground floor spaces - the parlor, considered to be the best and least used room; the living room, considered the room used for day to day family activities; and the kitchen all have different relative asymmetry (RA) values. The space with the highest value and therefore the most segregated, is the parlor, the kitchen is next, with the living room being the most integrated space. In the transformed house (Figure 61), the order of the RA values, from highest to lowest remains the same as in the original house but the numbers for each room are lower. Hillier and Hanson (1984) interpret this to mean that room uses have not changed but have loosened. The lower RA values in the transformed house show less distinction between the spaces and would indicate a less formal adherence to socio-spatial divisions. It is possible that everyday life, although still centered in the living room, spills over into the kitchen and parlor as well. The order of the RA values for the principle rooms is not the only significant observation to be made in this example. While the RA values for the rooms in the transformed house are lower than in the original house, the RA value for the carrier of the entire building increases from the original house to the transformed house. This indicates that the interior of the transformed house is more segregated from the exterior than in the original house. There have also been changes in regard to ringiness from the old to the transformed house. In the original house the ring is not internal to the house but passes through the carrier. At the deepest point on this ring (with respect to the carrier) is the living

room, indicating that this space is important in mediating the relationship of the interior and the exterior of the house. The transformed house has four rings, two of which are internal. The living room is still a central feature of the rings, but since these rings are internal there has been a shift of control. The living room serves the transformed house as a control of interior space rather than, as in the original house, as a mediator of exterior and interior relationship (Hillier & Hanson, 1984).

The relations of the rooms, as well as the relations of the interior to the exterior can be examined here from a class perspective, as the authors have done (Hillier & Hanson, 1984), and also from a gender perspective, as will be used in the proposed research. From a perspective of class the relative asymmetries, while remaining in the same order for the transformed space, are of a lower numerical value because they represent a design developed for the middle class and therefore reflect the space of a single class (Hillier & Hanson, 1984). The RA values are higher for the original house due to a very concrete vision of who was permitted to use each room based on status. In other words, the spaces were designed to fulfill a social hierarchy. A gender analysis of the three main spaces would reflect on the kitchen in both cases being the second most segregated room (after the parlor). The high RA value of this room represents a segregation between the spheres of men and women and yet its location, between the living room (the most integrated room) and the yard indicates a dependence of the household on women (Hillier & Hanson, 1984). The assumption of the spatial organization in both

cases is that women are the dominant force in the household, and that they are primarily active in the kitchen and the yard. In this way the house reflects not only a family system but a social system (Hillier & Hanson, 1984), and in this case a social system that actively segregates men and women.

APPENDIX F

CHECK LIST FOR SINGLE FAMILY DETACHED HOUSE FLOOR PLAN ANNOTATED ANALYSIS
St. Paul, MN: Two Bedroom Single Family Detached House

Entry
E-1 The entry is a focal point.
* E-2 The entry leads to circulation to other areas of the house.
E-3 The entry offers no direct view into any room.
Score: 0.333

Hall
* H-1 The hall provides access to all areas.
Score: 1.000

Living room
* L-1 Traffic from the front door does not directly enter the living room.
* L-2 The living room is not affected by street noise.
* L-3 The bathroom is out of sight and sound from living room.
* L-4 The living room connects to the dining room.
* L-5 The living room is not used as a pathway.
Score: 1.000

Family room
F-1 The family room should be away from the sleeping areas.
F-2 The family room is separate from but near to the living room.
F-3 The family room is near the kitchen.
F-4 The family room is not used as a pathway.
There is no family room.

Dining room
* D-1 The dining room is adjacent to the living area.
* D-2 The dining room is adjacent to the kitchen.
* D-3 The dining room is between the living room and the kitchen.
Score: 1.000

Kitchen
K-1 The kitchen is near the dining room but able to be closed off from it.
K-2 The indoor play area is visible from kitchen.
* K-3 The kitchen is near the service and garage areas.
K-4 The kitchen is near to a bathroom.
K-5 The kitchen is close to outdoor access.
Score: 0.200

Bathroom
* Ba-1 The bathroom is near the bedrooms.
* Ba-2 Bathroom noises are insulated from other spaces.

Ba-3 There are at least one and one half baths per house.
Ba-4 There is no view into an open bathroom door.
Score: 0.500

Bedroom
* B-1 The bedroom opens into a hall.
B-2 The bedroom is large enough to accommodate living spaces.
* B-3 The bedroom is in a quiet area.
* B-4 The bedroom is private.
* B-5 The bedroom is near a bathroom.
* B-6 The bedroom is away from major living areas.
Score: 0.833

Outdoor space
O-1 The primary outdoor spaces are at the back of the house.
O-2 There is easy access to the house.
O-3 The outdoor areas are secluded from the street.
Score: Does not apply here.

Total score: 0.540

CHECK LIST FOR SINGLE FAMILY DETACHED HOUSE FLOOR PLAN ANNOTATED ANALYSIS
St. Paul, MN: Three Bedroom Single Family Detached House

Entry
* E-1 The entry is a focal point.
* E-2 The entry leads to circulation to other areas of the house.
* E-3 The entry offers no direct view into any room.
Score: 1.000

Hall
* H-1 The hall provides access to all areas.
Score: 1.000

Living room
* L-1 Traffic from the front door does not directly enter the living room.
* L-2 The living room is not affected by street noise.
* L-3 The bathroom is out of sight and sound from living room.
* L-4 The living room connects to the dining room.
* L-5 The living room is not used as a pathway.
Score: 1.000

Family room
F-1 The family room should be away from the sleeping areas.
F-2 The family room is separate from but near to the living room.
F-3 The family room is near the kitchen.
F-4 The family room is not used as a pathway.
There is no family room.

Dining room
* D-1 The dining room is adjacent to the living area.
* D-2 The dining room is adjacent to the kitchen.
* D-3 The dining room is between the living room and the kitchen.
Score: 1.000

Kitchen
K-1 The kitchen is near the dining room but able to be closed off from it.
K-2 The indoor play area is visible from kitchen.
* K-3 The kitchen is near the service and garage areas.
K-4 The kitchen is near to a bathroom.
* K-5 The kitchen is close to outdoor access.
Score: 0.400

Bathroom
* Ba-1 The bathroom is near the bedrooms.
* Ba-2 Bathroom noises are insulated from other spaces.
* Ba-3 There are at least one and one half baths per house.
* Ba-4 There is no view into an open bathroom door.

Score: 1.000

Bedroom
* B-1 The bedroom opens into a hall.
  B-2 The bedroom is large enough to accommodate living spaces.
  B-3 The bedroom is in a quiet area.
* B-4 The bedroom is private.
* B-5 The bedroom is near a bathroom.
* B-6 The bedroom is away from major living areas.
Score: 0.666

Outdoor space
* O-1 The primary outdoor spaces are at the back of the house.
* O-2 There is easy access to the house.
* O-3 The outdoor areas are secluded from the street.
Score: 1.000

Total score: 0.790

CHECK LIST FOR SINGLE FAMILY DETACHED HOUSE FLOOR PLAN ANNOTATED ANALYSIS
Denver, CO: Two Bedroom Single Family Detached House

Entry
E-1 The entry is a focal point.
E-2 The entry leads to circulation to other areas of the house.
E-3 The entry offers no direct view into any room.
Score: 0.000

Hall
* H-1 The hall provides access to all areas.
Score: 1.000

Living room
L-1 Traffic from the front door does not directly enter the living room.
L-2 The living room is not affected by street noise.
* L-3 The bathroom is out of sight and sound from living room.
* L-4 The living room connects to the dining room.
L-5 The living room is not used as a pathway.
Score: 0.40

Family room
* F-1 The family room should be away from the sleeping areas.
* F-2 The family room is separate from but near to the living room.
F-3 The family room is near the kitchen.
F-4 The family room is not used as a pathway.
Score: 0.500

Dining room
* D-1 The dining room is adjacent to the living area.
* D-2 The dining room is adjacent to the kitchen.
D-3 The dining room is between the living room and the kitchen.
Score: 0.666

Kitchen
K-1 The kitchen is near the dining room but able to be closed off from it.
K-2 The indoor play area is visible from kitchen.
K-3 The kitchen is near the service and garage areas.
K-4 The kitchen is near to a bathroom.
K-5 The kitchen is close to outdoor access.
Score: 0.000

Bathroom
* Ba-1 The bathroom is near the bedrooms.
* Ba-2 Bathroom noises are insulated from other spaces.
Ba-3 There are at least one and one half baths per house.
* Ba-4 There is no view into an open bathroom door.

Score: 0.750

Bedroom
* B-1 The bedroom opens into a hall.
B-2 The bedroom is large enough to accommodate living spaces.
* B-3 The bedroom is in a quiet area.
* B-4 The bedroom is private.
* B-5 The bedroom is near a bathroom.
* B-6 The bedroom is away from major living areas.
Score: 0.833

Outdoor space
O-1 The primary outdoor spaces are at the back of the house.
O-2 There is easy access to the house.
O-3 The outdoor areas are secluded from the street.
Score: Does not apply here.

Total score: 0.460

CHECK LIST FOR SINGLE FAMILY DETACHED HOUSE FLOOR PLAN ANNOTATED ANALYSIS
Denver, CO: Three Bedroom Single Family Detached House

Entry
* E-1 The entry is a focal point.
E-2 The entry leads to circulation to other areas of the house.
E-3 The entry offers no direct view into any room.
Score: 0.333

Hall
* H-1 The hall provides access to all areas.
Score: 1.000

Living room
L-1 Traffic from the front door does not directly enter the living room.
L-2 The living room is not affected by street noise.
L-3 The bathroom is out of sight and sound from living room.
L-4 The living room connects to the dining room.
* L-5 The living room is not used as a pathway.
Score: 0.200

Family room
F-1 The family room should be away from the sleeping areas.
F-2 The family room is separate from but near to the living room.
F-3 The family room is near the kitchen.
F-4 The family room is not used as a pathway.
Score: 0.000

Dining room
D-1 The dining room is adjacent to the living area.
D-2 The dining room is adjacent to the kitchen.
D-3 The dining room is between the living room and the kitchen.
Score: 0.000

Kitchen
K-1 The kitchen is near the dining room but able to be closed off from it.
K-2 The indoor play area is visible from kitchen.
K-3 The kitchen is near the service and garage areas.
* K-4 The kitchen is near to a bathroom.
* K-5 The kitchen is close to outdoor access.
Score: 0.400

Bathroom
* Ba-1 The bathroom is near the bedrooms.
Ba-2 Bathroom noises are insulated from other spaces.
* Ba-3 There are at least one and one half baths per house.
* Ba-4 There is no view into an open bathroom door.

Score: 0.750

Bedroom
* B-1 The bedroom opens into a hall.
B-2 The bedroom is large enough to accommodate living spaces.
* B-3 The bedroom is in a quiet area.
* B-4 The bedroom is private.
* B-5 The bedroom is near a bathroom.
* B-6 The bedroom is away from major living areas.
Score: 0.833

Outdoor space
* O-1 The primary outdoor spaces are at the back of the house.
* O-2 There is easy access to the house.
* O-3 The outdoor areas are secluded from the street.
Score: 1.000

Total score: 0.500

CHECK LIST FOR SINGLE FAMILY DETACHED HOUSE FLOOR PLAN ANNOTATED ANALYSIS
Providence, RI: Three bedroom single family detached house.

Entry
* E-1 The entry is a focal point.
* E-2 The entry leads to circulation to other areas of the house.
* E-3 The entry offers no direct view into any room.
Score: 1.000

Hall
* H-1 The hall provides access to all areas.
Score: 1.000

Living room
* L-1 Traffic from the front door does not directly enter the living room.
* L-2 The living room is not affected by street noise.
* L-3 The bathroom is out of sight and sound from living room.
* L-4 The living room connects to the dining room.
* L-5 The living room is not used as a pathway.
Score: 1.000

Family room
F-1 The family room should be away from the sleeping areas.
F-2 The family room is separate from but near to the living room.
F-3 The family room is near the kitchen.
F-4 The family room is not used as a pathway.
There is no family room.

Dining room
* D-1 The dining room is adjacent to the living area.
* D-2 The dining room is adjacent to the kitchen.
* D-3 The dining room is between the living room and the kitchen.
Score: 1.000

Kitchen
K-1 The kitchen is near the dining room but able to be closed off from it.
K-2 The indoor play area is visible from kitchen.
K-3 The kitchen is near the service and garage areas.
* K-4 The kitchen is near to a bathroom.
K-5 The kitchen is close to outdoor access.
Score: 0.200

Bathroom
* Ba-1 The bathroom is near the bedrooms.
Ba-2 Bathroom noises are insulated from other spaces.
Ba-3 There are at least one and one half baths per house.
* Ba-4 There is no view into an open bathroom door.

Score: 0.500

Bedroom
* B-1 The bedroom opens into a hall.
  B-2 The bedroom is large enough to accommodate living spaces.
  B-3 The bedroom is in a quiet area.
* B-4 The bedroom is private.
* B-5 The bedroom is near a bathroom.
* B-6 The bedroom is away from major living areas.
Score: 0.666

Outdoor space
* O-1 The primary outdoor spaces are at the back of the house.
* O-2 There is easy access to the house.
* O-3 The outdoor areas are secluded from the street.
Score: 1.000

Total score: 0.630

CHECKLIST FOR SINGLE PARENT FAMILY HOUSING ANNOTATED ANALYSIS
St. Paul, MN: Dayton Court Two Bedroom Unit

Entry
E-1 The entry is clearly articulated.
* E-2 The entry has a direct connection to the outdoors.
* E-3 The entry has immediate access to the living room.
* E-4 The entry has access to all circulation paths.
* E-5 The entry does not provide visual access to bedrooms or baths.
E-6 The entry has space to dress children for outdoor play.
Score: 0.666

Living room
* L-1 The living room is close to the entry.
* L-2 The living room has direct access to the outdoors.
* L-3 The living room has natural light and ventilation.
Score: 1.000

Dining room
D-1 The kitchen and the dining room as one space is preferred.
* D-2 The dining room is adjacent to the kitchen.
Score: 0.500

Kitchen
K-1 The kitchen and dining room as one space is preferred.
K-2 The kitchen is large.
* K-3 The kitchen has direct access to the outdoors.
Score: 0.333

Bathroom
* Ba-1 The bathroom is close to bedrooms.
* Ba-2 The bathroom is easily accessed from the living areas.
Score: 1.000

Bedroom
* B-1 The bedroom is private.
* B-2 The bedroom is away from the living areas.
B-3 The bedroom is arranged around a short hallway.
B-4 The bedroom is easily monitored by the parent.
* B-5 The bedroom is large enough to serve as play areas.
B-6 The bedroom has ample storage or closet space.
Score: 0.500

Outdoor space
* O-1 Each unit should have direct access to the outdoors where possible.
* O-2 Outdoor access is close to the living areas.
* O-3 Ground level access (no steps) is preferred.
* O-4 Provide private decks where ground level access is impossible.

Score: 1.000

Total Score: 0.710

CHECKLIST FOR SINGLE PARENT FAMILY HOUSING ANNOTATED ANALYSIS
St. Paul, MN: Dayton Court Three Bedroom Unit

Entry
E-1 The entry is clearly articulated.
* E-2 The entry has a direct connection to the outdoors.
* E-3 The entry has immediate access to the living room.
* E-4 The entry has access to all circulation paths.
* E-5 The entry does not provide visual access to bedrooms or baths.
E-6 The entry has space to dress children for outdoor play.
Score: 0.666

Living room
* L-1 The living room is close to the entry.
* L-2 The living room has direct access to the outdoors.
* L-3 The living room has natural light and ventilation.
Score: 1.000

Dining room
D-1 The kitchen and the dining room as one space is preferred.
* D-2 The dining room is adjacent to the kitchen.
Score: 0.500

Kitchen
K-1 The kitchen and dining room as one space is preferred.
K-2 The kitchen is large.
* K-3 The kitchen has direct access to the outdoors.
Score: 0.333

Bathroom
* Ba-1 The bathroom is close to bedrooms.
Ba-2 The bathroom is easily accessed from the living areas.
Score: 0.500

Bedroom
* B-1 The bedroom is private.
* B-2 The bedroom is away from the living areas.
B-3 The bedroom is arranged around a short hallway.
B-4 The bedroom is easily monitored by the parent.
* B-5 The bedroom is large enough to serve as play areas.
B-6 The bedroom has ample storage or closet space.
Score: 0.500

Outdoor space
* O-1 Each unit should have direct access to the outdoors where possible.
* O-2 Outdoor access is close to the living areas.
* O-3 Ground level access (no steps) is preferred.
* O-4 Provide private decks where ground level access is impossible.

Score: 1.000

Total Score: 0.640

CHECKLIST FOR SINGLE PARENT FAMILY HOUSING ANNOTATED ANALYSIS
Denver, CO: Warren Village Two Bedroom Unit

Entry
* E-1 The entry is clearly articulated.
E-2 The entry has a direct connection to the outdoors.
E-3 The entry has immediate access to the living room.
* E-4 The entry has access to all circulation paths.
E-5 The entry does not provide visual access to bedrooms or baths.
E-6 The entry has space to dress children for outdoor play.
Score: 0.333

Living room
L-1 The living room is close to the entry.
L-2 The living room has direct access to the outdoors.
* L-3 The living room has natural light and ventilation.
Score: 0.333

Dining room
D-1 The kitchen and the dining room as one space is preferred.
* D-2 The dining room is adjacent to the kitchen.
Score:0.500

Kitchen
K-1 The kitchen and dining room as one space is preferred.
K-2 The kitchen is large.
K-3 The kitchen has direct access to the outdoors.
Score: 0.000

Bathroom
Ba-1 The bathroom is close to bedrooms.
Ba-2 The bathroom is easily accessed from the living areas.
Score: 0.000

Bedroom
* B-1 The bedroom is private.
B-2 The bedroom is away from the living areas.
B-3 The bedroom is arranged around a short hallway.
B-4 The bedroom is easily monitored by the parent.
B-5 The bedroom is large enough to serve as play areas.
* B-6 The bedroom has ample storage or closet space.
Score: 0.332

Outdoor space
O-1 Each unit should have direct access to the outdoors where possible.
O-2 Outdoor access is close to the living areas.
O-3 Ground level access (no steps) is preferred.
O-4 Provide private decks where ground level access is impossible.

Score: Does not apply here.

Total score: 0.210

CHECKLIST FOR SINGLE PARENT FAMILY HOUSING ANNOTATED ANALYSIS
Denver, CO: Warren Village Three Bedroom Unit

Entry
* E-1 The entry is clearly articulated.
E-2 The entry has a direct connection to the outdoors.
E-3 The entry has immediate access to the living room.
* E-4 The entry has access to all circulation paths.
E-5 The entry does not provide visual access to bedrooms or baths.
E-6 The entry has space to dress children for outdoor play.
Score: 0.333

Living room
L-1 The living room is close to the entry.
L-2 The living room has direct access to the outdoors.
* L-3 The living room has natural light and ventilation.
Score: 0.333

Dining room
D-1 The kitchen and the dining room as one space is preferred.
* D-2 The dining room is adjacent to the kitchen.
Score:0.500

Kitchen
K-1 The kitchen and dining room as one space is preferred.
K-2 The kitchen is large.
K-3 The kitchen has direct access to the outdoors.
Score: 0.000

Bathroom
* Ba-1 The bathroom is close to bedrooms.
* Ba-2 The bathroom is easily accessed from the living areas.
Score: 1.000

Bedroom
* B-1 The bedroom is private.
B-2 The bedroom is away from the living areas.
B-3 The bedroom is arranged around a short hallway.
B-4 The bedroom is easily monitored by the parent.
B-5 The bedroom is large enough to serve as play areas.
* B-6 The bedroom has ample storage or closet space.
Score: 0.332

Outdoor space
O-1 Each unit should have direct access to the outdoors where possible.
O-2 Outdoor access is close to the living areas.
O-3 Ground level access (no steps) is preferred.
O-4 Provide private decks where ground level access is impossible.

Score: Does not apply here.

Total score: 0.450

CHECKLIST FOR SINGLE PARENT FAMILY HOUSING ANNOTATED ANALYSIS
Providence, RI: Women's Development Corp. Three Bedroom Prototype Unit

Entry
* E-1 The entry is clearly articulated.
* E-2 The entry has a direct connection to the outdoors.
* E-3 The entry has immediate access to the living room.
* E-4 The entry has access to all circulation paths.
* E-5 The entry does not provide visual access to bedrooms or baths.
E-6 The entry has space to dress children for outdoor play.
Score: 0.833

Living room
* L-1 The living room is close to the entry.
L-2 The living room has direct access to the outdoors.
* L-3 The living room has natural light and ventilation.
Score: 0.666

Dining room
* D-1 The kitchen and the dining room as one space is preferred.
* D-2 The dining room is adjacent to the kitchen.
Score: 1.000

Kitchen
* K-1 The kitchen and dining room as one space is preferred.
K-2 The kitchen is large.
K-3 The kitchen has direct access to the outdoors.
Score: 0.333

Bathroom
* Ba-1 The bathroom is close to bedrooms.
* Ba-2 The bathroom is easily accessed from the living areas.
Score: 1.000

Bedroom
* B-1 The bedroom is private.
* B-2 The bedroom is away from the living areas.
B-3 The bedroom is arranged around a short hallway.
B-4 The bedroom is easily monitored by the parent.
B-5 The bedroom is large enough to serve as play areas.
* B-6 The bedroom has ample storage or closet space.
Score 0.500

Outdoor space
O-1 Each unit should have direct access to the outdoors where possible.
O-2 Outdoor access is close to the living areas.
O-3 Ground level access (no steps) is preferred.

O-4 Provide private decks where ground level access is impossible.
Score: Does not apply here.

Total score: 0.630

APPENDIX G

SPSS T-Test Procedure

Analysis of relative asymmetry value differences by housing type.

SPSS Program

```
SET MORE=OFF
      /SCREEN=OFF
      /EJECT=OFF
      /LISTING='RA1.LIS'
      /RUNREVIEW=MANUAL.

DATA LIST FREE
      /HTYPE RA.
BEGIN DATA.
1 0.341
1 0.257
1 0.407
1 0.313
1 0.222
2 0.467
2 0.463
2 0.311
2 0.311
2 0.288
END DATA.

T-TEST GROUPS=HTYPE(1,2)
      /VARIABLES=RA.

FINISH.

      /RUNREVIEW=MANUAL.

DATA LIST FREE
      /HTYPE RA.
BEGIN DATA.
END DATA.

T-TEST GROUPS=HTYPE(1,2)
      /VARIABLES=RA.
```

Analysis of relative asymmetry value differences by housing type.

SPSS output

Independent samples of HTYPE

Group 1: HTYPE EQ 1.00 Single family detached houses
Group 2: HTYPE EQ 2.00 Single parent family dwellings

t-test for: Relative Asymmetry Values

	Number of Cases	Mean	Standard Deviation	Standard Error
Group 1	5	.3080	.072	.032
Group 2	5	.3680	.089	.040

		Pooled Variance Estimate			Separate Variance Estimate		
F Value	2-Tail Prob.	t Value	Degrees of Freedom	2-Tail Prob.	t Value	Degrees of Freedom	2-Tail Prob.
1.52	.696	-1.17	8	.276	-1.17	7.68	.277

Analysis of annotated analysis score differences by housing type.

SPSS program

```
SET MORE=OFF
      /SCREEN=OFF
      /EJECT=OFF
      /LISTING='AA1.LIS'
      /RUNREVIEW=MANUAL.

DATA LIST FREE
      /HTYPE AA.
BEGIN DATA.
1 0.540
1 0.790
1 0.460
1 0.500
1 0.630
2 0.710
2 0.640
2 0.210
2 0.450
2 0.620
END DATA.

T-TEST GROUPS=HTYPE(1,2)
      /VARIABLES=AA.

FINISH.

      /RUNREVIEW=MANUAL.

DATA LIST FREE
      /HTYPE AA.
BEGIN DATA.
END DATA.

T-TEST GROUPS=HTYPE(1,2)
      /VARIABLES=AA.
```

Analysis of annotated analysis score differences by housing type.

SPSS output

Independent samples of HTYPE

Group 1: HTYPE EQ 1.00 Single family detached houses
Group 2: HTYPE EQ 2.00 Single parent family dwellings

t-test for: Relative Asymmetry Values

	Number of Cases	Mean	Standard Deviation	Standard Error
Group 1	5	.5840	.131	.059
Group 2	5	.5260	.201	.090

		Pooled Variance Estimate			Separate Variance Estimate		
F Value	2-Tail Prob.	t Value	Degrees of Freedom	2-Tail Prob.	t Value	Degrees of Freedom	2-Tail Prob.
2.34	.430	0.54	8	.604	0.54	6.89	.606

APPENDIX H

Definition of Terms

The following terms have been defined for use in this study:

Asymmetric: An asymmetric relation in this study will involve the notion of depth: that is in order to reach point (c), one must pass through point (b) from point (a). An asymmetric relation of space will indicate a tendency toward segregation of social categories (Hillier & Hanson, 1984).

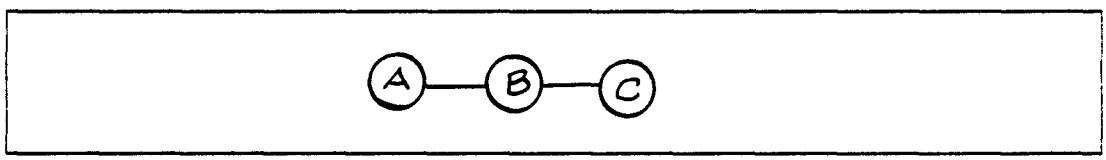


Figure 62. Asymmetry.

Carrier of the system: The point of reference for the gamma analysis of interior space (Hillier & Hanson, 1984).

Depth: The distance a particular space is from the carrier. Depth is counted as the number of spaces from the carrier rather than as a measured distance (Hillier & Hanson, 1984).

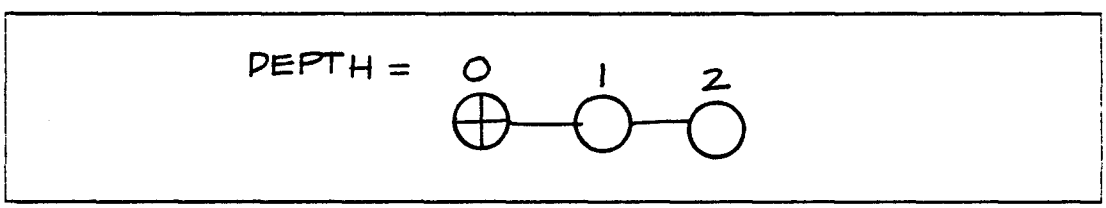


Figure 63. Depth.

Distributed: The relation between two spaces is distributed if there is more than one non-intersecting route from point (a) to point (b) (Hillier & Hanson, 1984).

Family: In order to be as non-restrictive as possible, for the purposes of this study, "family" will be defined as a single house-

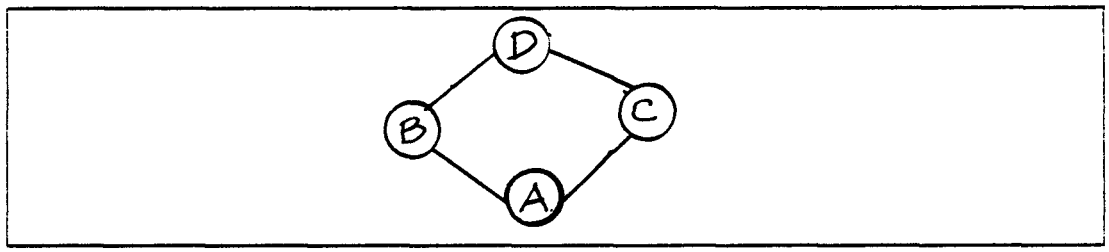


Figure 64. Distributedness.

keeping unit (Ritzdorf, 1988).

Single parent family: A family with children under 18 years of age in which the female household head has either never been married, is divorced, or is otherwise living as the only adult in the household.

Gamma map: A method of describing the space of a building in an abstract way in order to more clearly see the patterns of control of the spaces (Hillier & Hanson, 1984). A gamma map uses circles to represent spaces and lines to represent the permeability of those spaces.

Housing: A dwelling unit.

Justified gamma map: A justified gamma brings the concept of depth to a gamma map by aligning horizontally all spaces in a building that occur at the same depth from the carrier (Hillier & Hanson, 1984).

Mean depth: The arithmetic mean of the total of the depths for each space from the carrier. In gamma analysis the mean depth of each space may change as each analyzed room becomes the carrier (Hillier & Hanson, 1984).

Nondistributed: The relation between two spaces if there is only one route from point (a) to point (b) (Hillier & Hanson, 1984).

Nuclear Family: A group consisting of two parents and children.

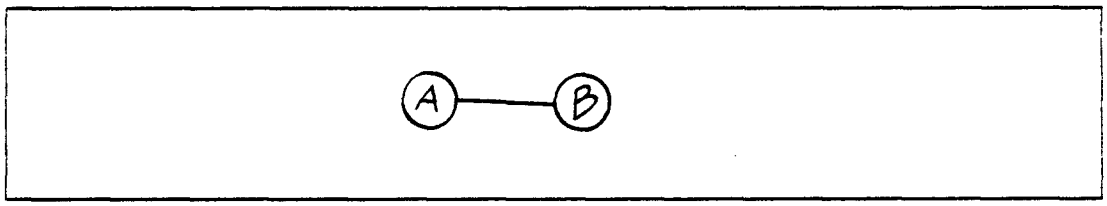


Figure 65. Nondistributedness.

Relative asymmetry (RA): A measure of the integration of space determined by the formula RA = 2(MD-1)/(k-2). Where MD is the mean depth, and k is the number of spaces in a building (Hillier & Hanson, 1984).

Ringiness: The circular aspect of space and the connections between spaces (Hillier & Hanson, 1984).

Single family detached housing: Detached housing located in an area zoned specifically to allow only one family per dwelling unit.

Social logic of space: The social consequences of the built environment (Hillier & Hanson, 1984).

Starter homes: Newly constructed single family detached housing most typically sold to first time home buyers.

Space link ratio: A means of determining the ratio of spaces to connections in a building (Hillier, Hanson, & Graham, 1987).

Symmetric: The notion of symmetry in this study will follow the mathematical definition: (a) is symmetric to (b) if the relationship of (a) to (b) is the same as the relation of (b) to (a). A symmetric relation of space will indicate a tendency toward integration of social categories (Hillier & Hanson, 1984).

Traditional family: A married couple with children under 18 years of age with an employed husband and a homemaker wife (Ahrentzen, 1989).

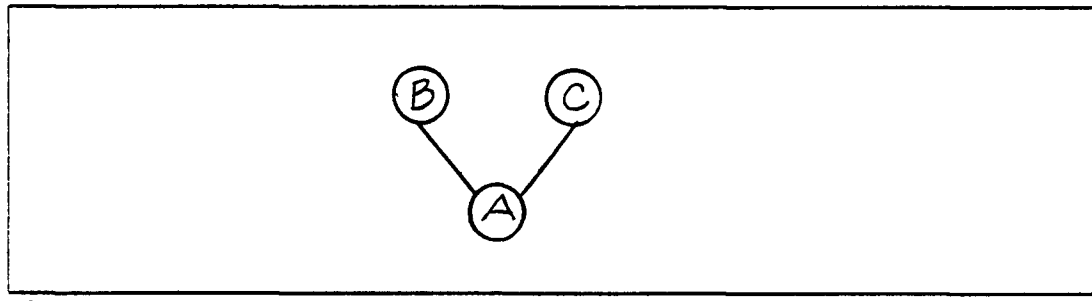


Figure 66. Symmetry.