Study of the Domestic Open Spaces in Low-Rise Dwelling Units in Riyadh, Saudi Arabia

by

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(ABSTRACT)

In the last four decades, Saudi Arabia has undergone rapid urban development. One consequence of this is the emergence of the villa-type dwelling unit as a standard contemporary house design. The domestic open space of each unit is the space surrounding the form of the house. This contemporary domestic open space has failed to meet the basic cultural need for privacy and the demands of the local climate. The aim of this study is to describe the need for privacy as a determining cultural aspect, and climatic comfort in the contemporary domestic open space within the existing cultural and environmental context. The study analyzes the traditional domestic open space to provide clues to direct and improve the existing situation. Design options or guidelines based on the analysis of the contemporary and traditional domestic open spaces are proposed to improve the domestic open space within the villa house pattern.
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Introduction

In the last four decades, Saudi Arabia has undergone rapid urban development. Riyadh, the capital city, experienced extremely rapid growth involving all the latest facilities modern technology has to offer. The new physical environment resulting from exotic technology introduces foreign building types, land development patterns, and urban services such as roads and parking areas. This new physical environment differs greatly from the traditional one.

Because of the adoption of these technologies, the Saudi standard of living has changed rapidly during the last few decades. Tradition, basic religion principles, and vernacular factors play less dominant roles in shaping residential Saudi dwelling, although these factors are still considered to be extremely important by the people.

One consequence is the emergence of the villa-type dwelling unit as a standard contemporary house design. A typical villa is two storeys high with large balconies and windows opening on all four sides. The domestic open space of each unit is the leftover space
surrounding the form of the dwelling. A high wall of two meters or higher is built around the property line.

Traditionally, open spaces in the Saudi environment grew as a direct response to the needs, aspirations, and ethos of the society. They were then adjusted and modified by many other factors such as religion, cultural background, and macro- and micro climatic conditions. The contemporary villa-style house with its values and principles foreign to the people and the environment is causing a conflict between the old and the new. The outcome is a conglomeration of architecture which fails to meet the basic Saudi cultural need for privacy or the demands of the local climate.

Abraham Maslow the social theorist, in his book Toward A Psychology of Being argues that there is a hierarchical order for the need of human life. The human being, as part of his intrinsic construction, has not only physiological needs, but also truly psychological ones. They may be considered as deficiencies which must be optimally fulfilled by the environment in order to avoid sickness and subjective ill-being. These needs and values are related to each other in a hierarchical and developmental way. In an order of strength and of priority, safety is a stronger, more pressing, more vital need than love, for instance, and the need for food is usually stronger than either. Furthermore, all these basic needs may be considered to be simply steps along the path to general self-actualization, under which all basic needs can be subsumed (Maslow 1968).

This theory of the hierarchical order of the basic human needs has been traced by Lois Gottlieb, in her book Environment and Design in Housing, in world architecture. Man’s first environmental problem was the search for shelter in order to protect himself physically against climatic elements, other animals, and men. He solved that problem either by finding a ready made shelter or by constructing little shelters. The first constructed
shelters were out of available materials. Therefore, people in different geographical locations developed different forms of shelters. These were all intended to solve the same needs and to express the same idea: that of providing physical protection in the simplest possible way (Gottlieb 1965).

Several things have changed greatly since primitive man began establishing shelters. The most important change is in man's ability to consider other factors over and above the simple need of physical shelter. Of these factors, the behavioral ones emerge as significant elements affecting design. Behavioral factors related to architecture include a wide range of human concerns, responses, and attitudes. In almost all societies the desire for personal privacy has become the determining behavioral factor in shaping architectural space.

Although the Kingdom of Saudi Arabia is one of the few countries where people still share the same ideas within their tradition and its citizens also possess all the latest facilities that modern technology has to offer. Because of the adaptation of these technologies, the standard of living has changed greatly creating more demands. The problem is that in an effort to respond, contemporary domestic open space in the villa has overlooks more primary needs. This is particularly true of the domestic open space immediately adjacent to residential structures.

Traditionally, domestic open space in the Saudi environment has developed in response to the religion and culture of the society and to the macro- and microclimatic conditions. It should be recognized that the courtyard house was already being constructed by other societies during the ancient oriental civilizations in classical Greece and in the Roman Empire centuries before Islam. Perhaps this was because people had already found it suited their local needs. As in the case of other type of architecture, Islamic society has
nevertheless been reinterpreting and readapting houses over the centuries, gradually adding many refinements. When carefully analyzed, the models of Islamic courtyard houses thus appear not only totally different from their Roman predecessors, but also exhibit strong variety from one county, or sometime one city, to another. This again demonstrates a better adaptation to local conditions.

It is my assertion (hypothesis) that the traditional courtyard house can, through careful analysis, provide clues to direct and improve the domestic open space in the contemporary dwelling units.

In this study I will:

1. document apparent problems in the domestic open space of the villa house based on environmental clues and literature review;

2. systematically analyze the courtyard house as an archetype to determine the applicability of the design principles employed to contemporary Saudi residential domestic open space; and

3. establish guidelines to the extent possible based on the analysis of the existing situation and the analysis of the courtyard house which could be used to improve open spaces within the villa house pattern of land development in Riyadh, Saudi Arabia.
II.  Historical Background of the Housing Developments in Riyadh

Riyadh City is located in the middle of the *Najd* region on the Arabian peninsula. It is situated on a plateau which rises 600 meters above sea level. The city assumed little prominence until Abd Al-Aziz Al Saud became its independent governor in 1902 and began his military campaign for the consolidation of modern Saudi Arabia. Since that time, Riyadh has become the permanent residence of the King and the capital of the country Figure 1 on page 7.

The city maintained its size inside its fortification walls as shown in Figure 2 on page 8 until the end of the campaign in 1938 and the consolidation of the Kingdom. At that time, King Abd Al-Aziz himself took the first step in influencing the city's physical development when he decided to move outside the city walls. In a location two kilometers north of the town center, Al-Murabba, a large complex of palaces and administrative buildings were built for the King and his entourage.
The Al-Murabba complex was built out of dried mud bricks and other local materials. The design of the complex was based on traditional forms of architecture. Each building enclosed one or more courtyards as shown in Figure 3 on page 9 and in Figure 4 on page 10). Thus, the departure of Al Murabba from the traditional urban pattern lies mainly in the large size of its components and its location out side Riyadh's walls.

By building Al-Murabba, King Abd Al-Aziz established a precedent for Riyadh. The town limits were no longer the surrounding walls. It is now possible and secure for anybody to build outside the town walls. That action was the first step in expanding the size of Riyadh and establishing the direction of its physical growth.

This chapter provides background information about the city of Riyadh including a study of the regulations that allowed the contemporary villa house to be introduced and developed as the standard low-rise dwelling.
Figure 1. Map of the Arabian peninsula showing the location of Riyadh.

II. Historical Background of the Housing Developments in Riyadh
Figure 2. Map of Riyadh in 1919 — Philby’s map: (Riyadh Existing Conditions 1968).

II. Historical Background of the Housing Developments in Riyadh
Figure 3. Site plan of Al-Murabba: The complex is the shaded mass of building in the center (Riyadh Existing Conditions 1968).

II. Historical Background of the Housing Developments in Riyadh
Figure 4. View of the Royal Palace, Al-Murabba: Traditional design and building materials were used in the complex (Bahammam 1986).
A. The Beginning of the Change

In the early 1940s, Nasriyah was a small estate owned by King Saud, then a Crown Prince. It consisted of no more than a well and a four-acre garden. However, when King Saud succeeded his father to the throne in 1953, he decided to make Nasriyah the royal residence. The grounds were extended to 250 hectares, and plans were drawn up to include modern luxurious palaces, wide boulevards, and gardens laid out according to a grid pattern. When the entire project was completed in 1957, it consisted of the Royal Divan, six palaces, thirty-two large villas, and thirty-seven smaller villas as shown in Figure 5 on page 12 (Bahammam 1986).

Nasriyah was the turning point between the traditional and the modern in Saudi architecture. The conflict between the two kinds of architecture, the old and the new, was consciously started by the city’s residents. Contrary to the traditional pattern, Nasriyah was planned and designed. Reinforced concrete, cement blocks and asbestos tiles were used instead of traditional building materials and technology. The project demonstrated an alternative way of planning, designing and building. The project had a clear effect on Al-Malaz, the first housing project in Riyadh and in the country (Hathloul 1981).
Figure 5. Nasriyah, the Royal Resideace of King Saud: Nasriyah was the turning point between traditional and modern Saudi architecture. The wide street's system and the modern dwelling types are obvious in the design (Al-Hathloul 1981).

II. Historical Background of the Housing Developments in Riyadh
B. The First Housing Project

In 1953, King Saud decided to transfer all the government agencies from Makkah to Riyadh, the transferred government employees needed housing. The site of the project is located 4.5 kilometers northeast of the center of Riyadh and covers an area of about 500 hectares. The housing projects of ARAMCO, the Arabian American Oil Company, in the cities of the eastern province at the company employee oil camps in Daharan City in 1938 (Figure 8 on page 16), in Ras-Tanura City in 1944, in Abqaiq City in 1950, and through the ARAMCO Home Ownership plan for Saudi employees (Figure 9 on page 17) in 1951 inspired the project (Fadan 1983).

The Al-Malaz project consists of 754 detached outward looking dwelling units (villa types) and three apartment buildings. The project includes the required support facilities and services. The physical pattern of the project follows a gridiron plan with a hierarchy of streets, rectangular blocks, and large lots which, in most cases, take a square shape as shown in Figure 6 on page 14 and in Figure 7 on page 15. The first stages of the project were finished in 1957 when the transfer of the government agencies were completed. Because of the impact of the project on the size of Riyadh, Al-Malaz was called the "New Riyadh" (Bahammam 1986).

The combined impact of these different projects led to the rapid spread of the villa model throughout the country, and its later enforcement by municipal regulations.
Figure 6. Al-Malaz project: A new Street pattern-the grid, and a new house type-the villa (Al-Hathoul 1981).
Figure 7. Example of Al-Malaz dwellings: (Bahammam 1986).
Figure 8. Aerial view of ARAMCO's senior staff camp: The new street pattern and the new dwelling type in ARAMCO inspired the contemporary Saudi Architecture (Bahammam 1986 p. 143).
Figure 9. Typical dwelling built through ARAMCO Home Ownership Program: An outward looking dwelling built out of contemporary materials (Al-Hathloul 1981).
C. Zoning and Setback Regulations

The zoning regulations currently applied in Saudi cities originated, generally speaking, in Western nations in the late nineteenth and twentieth centuries and developed from value systems total different from those of Muslim society. The introduction of the setback and new building line requirements by Western planners and architects, for example, was intended to alleviate overcrowding, avoid fire hazards, and protect public health by providing light and air to all inhabitants. The concept of having an unbuilt space around building first took the form of law in London's Building Act in 1944.

In Saudi Arabia, the development and evolution of setback and building line requirement which opened the way for the detached, low-rise house (villa-type) to become the standard dwelling is best presented in three phases:

1. the development of regulations prior to 1970 when the first master plan for Riyadh was adopted;

2. the introduction of the new regulations by Doxiadis for the master plan of Riyadh; and

3. the modified regulations in the new master plan proposed for Riyadh and their implementation (Bahammam 1986).
1. Regulation in Practice before the Master Plan

By the late 1960s, the municipality of Riyadh and other municipalities in Saudi Arabia had put into practice, for the first time, several regulations pertaining to buildings on a plot of land. These regulations are:

- a built-up area generally should not exceed sixty percent of the land area;

- front setbacks should be equal or greater than one-fifth of the width of the road but should not exceed six meter;

- side and rear setbacks should not be less than two meters and building projections should not be permitted within this area as shown in the example in Figure 10 on page 22 (Al-Hathloul 1981).

2. The First Master Plan for Riyadh

Riyadh, in the 60s, was the fastest growing city in the country; therefore, the government felt the need to control and direct its growth. In 1966, the task of planning and formulating the capital was assigned to Doxiadis Associates of Athens which submitted the final master plan for Riyadh in 1971. The Doxiadis proposals reaffirmed the existing building setback requirements, in practice since the late 1960s, for all new residential areas of the city. The plan encouraged the municipality of Riyadh to relax its restrictions regarding window openings and intrusions on privacy. It also gave the municipality the authority it needed to make the setback requirements legal. From that
point on, the municipality make it explicitly acceptable for homes to have second-floor windows even if they overlooked the neighbors' open spaces (Bahammam, 1986).

3. The Modification of the Regulation by SCET

Riyadh faced a rapid urban growth in the mid 70s because of the oil boom and the government pressure for development. This growth went beyond the boundaries laid out by Doxiadis in the first master plan. In 1976, SCET International/SECES of Paris was assigned to the task of revising the Doxiadis master plan and prepare and action master plans and development studies for Riyadh.

By that time, it had become clear that some of the proposals and regulations of the Doxiadis plan did not fulfil the cultural needs of Saudi society. One of the aims of the SCET proposed zoning regulations was to ameliorate the cultural conflict that resulted from the Doxiadis master plan. To achieve this objective, the regulations brought about two major changes:

1. side and rear setback requirements in residential areas were abolished;

2. owners who wanted setbacks were permitted window openings from the second floor up.

However, certain conditions and standards had to be followed. The property owner either had to maintain a certain distance between any window and the property line of the neighbors, or the window had to be designed to prevent direct sight lines into neighboring properties as illustrated in Figure 11 on page 23) (Bahammam, 1986).
D. Current Building Regulations in Riyadh

The current setback regulations are the same regulations which were applied in the late 1960s and reaffirmed in 1971 in the Doxiadis master plan with one exception. Al-Urayja, a residential suburb in the southwest corner of Riyadh was built under the SCET modified regulations, which call for the abolition of all side and rear setback requirements. The municipality of Riyadh has approved the use of the detached and courtyard dwelling units in Al-Urayja as shown in Figure 12 on page 24 (Bahammam 1986).
TYPICAL MODERN VILLA-TYPE HOUSE DESIGN IN RIYADH

- Large windows and thin concrete walls provide little insulation against the summer heat and cold winter days.
- External windows of the type found in most modern villas do not protect from dust and noise, apart from the neglect of privacy.
- In consequence, habitable indoor climate relies entirely on mechanical air conditioning.
- Roof tops are seldom suited for outdoor family activities because privacy is not maintained.
- Wind, heat and glare make balconies costly though useless elements of the house.
- Gardens external to the house are, in full view of neighbouring houses are unsuitable for private family activities.
- Plot coverage of 50% and less make no economical use of the land.
- Narrow strips of 1 metre around the house often account for 22% of the unused plot area. Since this space is too narrow to be used, it represents a considerable waste of land.
- Large paved areas add to increased radiation of hot air in the evening.
- Large unprotected front yards are a waste of space often causing dust, sand and dust infiltration.

Figure 10. Typical modern villa type house design in Riyadh: (Riyadh Diplomatic Quarter 1978). p. 33.
Figure 11. Proposed zoning regulation by SCET: Controlling the setback to ensure privacy (Riyadh Action Master Plan 1982).

\[ x = d \frac{5-L}{L-2} \]

where

- \( d \) = width of the ground to be visually protected
- \( L \) = height of the dividing wall
- \( x \) = minimum distance at which window can normally be opened in a facade.
Figure 12. Example of the courtyard-type dwelling. (Municipality of Riyadh 1985).
III. Privacy of the Outdoor Space

The desire for privacy is a significant cultural factor influencing housing design in almost every society. To accommodate people’s need for privacy a wide range of solutions have evolved in various cultures as one of the basic demands on form. Architectural forms achieve privacy through physical means by planning, arranging, and creating an order of spaces which work together to provide privacy.

Privacy is the claim of individuals, groups, or institutions to determine for themselves when, how and to what extent information about them is communicated to others. Viewed in terms of the relation of the individual to social participation, privacy is the voluntary and temporary withdrawal of a person from the general society through physical or psychological means (Westin 1970).

This chapter will evaluate the use of the outdoor space in low-rise dwelling units according to the required privacy level of the Saudi people, and come out with recommendations to improve the existing situation of the domestic outdoor space and to guide for a better design in the future.
A. The Use of Space in Low-Rise Dwelling Units

Contemporary outdoor space replaces the traditional courtyard family space. It acts as a general space in the dwelling lot because it functions as the only link between the house interior and the street and because of its size, it is used for sitting, eating, gathering, celebrating, playing and gardening.

In terms of social life, the outdoor open space could provide an appropriate environment for favorable interactions. It meets the description of the Arab’s desirable space in Hall’s book *The Hidden Dimension*: Space in Arab’s houses are tremendous by European standards. They avoid partitions because Arabs do not like to be alone. Their personalities are intermingled and take nourishment from each other like the roots in soil. If one is not with people and actively involved in some way, one is deprived of life (Hall 1966).

The element which distinguish the traditional Saudi dwelling from the contemporary or the western one is the fluidity of social contact and the clear demarcation between public and private worlds. The traditional courtyard is located in the center of the house, surrounded by rooms and other active elements. It acts as a general space where nearly every movement between the elements of the house begins, ends, or passes through. It is designed to be the focal point of the house, drawing various activities from the rooms to its open space. In other words, the contemporary western dwelling style is quite the opposite of the traditional Saudi style. As we begin to experience space as an architectural element in the contemporary style, our perceptions turn literally inside out, as Carruthers Kenneth has described:

III. Privacy of the Outdoor Space
1. space is non-monumental and extroverted while space in the traditional style is monumental and introverted as shown in Figure 13 on page 28 and Figure 14 on page 29.

2. open space becomes outside, which means we stand outside the inside. In the traditional design the open space (which is the courtyard) becomes inside, which means we are inside the outside as shown in Figure 15 on page 30 and Figure 16 on page 31.

3. outdoor space is the leftover space while in the traditional style, the outdoor space is designed as surely a as monumental building is designed as shown in Figure 13 on page 28.
Figure 13. The monument of space: The traditional style space is monument (a); while in the contemporary style form is monument (b).
Figure 14. The traditional Saudi open space: In traditional Saudi architecture, as in most Islamic architecture, space is cut-out from the material form around it.
Figure 15. Definition of space: In traditional style space is inside the outside (a); in the contemporary style space is outside the inside (b).
Figure 16. The contemporary dwelling open space: In the contemporary design, the form of the house is placed within a space and the space is defined by the form it surrounds.
B. Privacy in Saudi Arabia

Islam is the religion of Saudi Arabia and that of its entire population. The heritage of the country, in past and present is based upon the Islamic faith. The legislation of the country is based on the Sharia, the Holy law, which is based on two important sources: the Qur'an, the revelations of Allah to the Prophet Mohammed through the angel Gabriel, and the Sunna, the utterances and actions of the Prophet who is believed by Muslims to have been divinely inspired in his actions and words (Ministry of Information, Saudi Arabia 1985).

C. Privacy in Islam

The Islamic faith encompasses every aspect of human life. It is a source of direct and continuous guidance in the political, economic, social and cultural life of its followers. Privacy is an important aspect of social life. The Islamic teachings which emanate from the Qur'an, the Holy Book of Muslims, and the Hadith, the sayings of the Prophet Mohammed, demand privacy.

Islamic teachings define three different spheres where individual protection from visual and acoustic invasion is required. They are:

1. privacy between neighbors' dwellings as well as between the individual dwelling and the street;
2. privacy between sexes; and

3. privacy between individual family members in a dwelling (Bahammam 1986, p.13).

In this study of the outdoor space in low-rise dwellings, the main privacy concern is for privacy between dwellings and the outside. This concern for a dwelling’s privacy is strongly related to the privacy between sexes.

1. Privacy Between Sexes

Privacy between the sexes results from the teachings of Islam. In Islamic teachings it is preferable for Muslim men and women to be segregated as much as possible from each other, in public and in private surroundings, unless the women and men are related by blood or marriage.

A Muslim man is expected to lower his gaze and not stare openly at women, while a Muslim woman outside of her house is expected to observe certain rules regarding dress. She is required to wear dress which covers all parts of her body so as not to reveal her figure. In the presence of her husband, family, or close female friends, however, a Muslim woman may wear whatever she pleases. When not with these specified individuals, only the hands and face could be left uncovered, say some scholars, while others state that the face, too, should be covered as shown in Figure 17 on page 35. This dress is called Hijab in Arabic, and it must be worn anywhere that the Muslim woman might be seen by males who are unrelated to her (Bahammam 1986).

In the Qur’an (Sura XXXIII: Ahzab: 59), Allah says:

III. Privacy of the Outdoor Space
O Prophet! Tell thy wives and daughters, and the believing women, that they should cast their outer garments over their persons (when abroad): that is most convenient, that they should be known (as such) and not molested. And God is Oft-Forgiving, Most Merciful (Yusuf Ali's translation 1983, pp. 1126-1127).

This Qur'anic verse and many others ensure a special form of privacy to protect Muslim women from the eyes of unrelated males. As a result of the need for this form of privacy, traditional Saudi dwellings employ a unique architectural use of space.

Space is built in the image of man, so it reflects man's behavior. As the human body is concealed behind its superficial appearance (clothing, gestures and behavior), the traditional design of the dwelling can be interpreted as the architecture of a veil. Each aspect reveals a degree and quality of privacy, ranging from public, semi-public and semi-private, to total privacy. Thus, the open space (courtyard) situated at the center can be compared to the inner most personality that hides itself inside the body. It is a complete reflection of the social behavior of the people as illustrated in Figure 18 on page 36.
Figure 17. Typical women's dress in Saudi Arabia: which is called Hijab (Bahammam 1986).
Total concealment of content

Veil covering the entire face.  Entrance covering the inner rooms.

Opening or introduction to inside world

Veil covers the head, though the face is now visible.  Intermediate area between public and private space.

Trust, exposure and familiarity

Veil is absent in the company of family.  Total privacy: no visual access to the outside world.

Figure 18. Architecture is the image of man: The reflection of human behavior on the traditional Saudi architecture. within a space and the space is defined by the form it surrounds.

III. Privacy of the Outdoor Space
2. Privacy Between Dwellings and the Outside

The basic idea of a dwelling is to provide protection and privacy from the outside. Privacy from the outside intrusion. Lois D. Gottlieb states in her book, Environment and Design in Housing (1965):

The most basic function of a dwelling is to create shelter and privacy. The physical shelter is created by roof and walls that will keep the rain off one's head and the cold out. But there is a need to have a feeling of shelter that demands more of our dwelling. A glass can be made to satisfy all of one's needs for physical shelter, but there are very few people who would feel sheltered in one; shelter must satisfy a physiological feeling of protection, a feeling that there is something solid around one.

Privacy between dwelling units and the outside is required to protect members of a dwelling, both male and female, from outside intrusion. The outside intrusion may be neighbors or passersby on the streets. Specific rules ensure the completely peaceful and tranquil environment of the dwelling (Bahammam 1986). In the Qur'an (Sura XXIV: Nur: 27), Allah:

O ye who believe! Enter not houses other than your own, until ye have asked permission and saluted those in them: that is best for you, in order that ye may heed (what is seemly) (Yusuf Ali's translation 1983, p. 903).

This verse is a strong commandment to ensure privacy in architecture. It guides Muslims to the proper behavior when entering houses other than their own. The Muslim principle of asking respectful permission and exchanging salutations ensures privacy. In explaining this verse, the Prophet said:

It is not lawful for a Muslim person to peep into the house of another person until he has asked permission. Otherwise, if he peeps into the house before asking permission, verily (it is as if) he had entered. Source: Bahammam 1986.
In this saying of the Prophet, he informs us that the act of looking into the houses of others is prohibited, and considered actual physical intrusion into the house. The Prophet makes a very clear statement about the need for full visual privacy for each individual dwelling. In general, the Qur'anic verse and the saying of the prophet have ensured a dwelling's privacy and protected it from intrusion.
a. *Intrusion from Above*

The idea behind the western concept of space which has been hastily adopted in modern Saudi dwellings is to consolidate the building form and leave space around it to give continuity to the streetscape and extend the visual attractions of the street. Loss of privacy to the public domain makes this design non-functional in Saudi Arabia. To make the space surrounding the dwelling work, an above eye-level wall has to be used. This wall has to be higher than the passersby's line of sight, which means 180 cm or more from the street, to separate private and public domains as shown in Figure 16 on page 31 and in Figure 19 on page 41.

In the contemporary detached outward oriented dwellings, the upper windows, balconies and terraces overlook nearby and adjacent properties and intrude into the private nature of the domestic life of the outdoor space of the neighbor’s dwellings as shown in Figure 19 on page 41 and in Figure 20 on page 42. This open space design fails to meet the standards of privacy required in Saudi Arabia.

Saudis still hold to their culture very strongly. Privacy remains a priority to the population. In an attempt to live with the new realities, residents have come out with some unique architectural solutions, the result of their involvement in redesigning and rearranging their dwellings, to suit their needs and provide privacy. Unfortunately, some of these attempts have resulted in poor architectural solutions, such as the addition of very high plastic or metal partitions above the exterior walls. These partitions are intended to close off the open space around the detached dwelling unit and to offset the problem of exposed outdoor space lying open to neighbors' eyes as illustrated in Figure 21 on page 43 and in Figure 22 on page 44. Figure 63 on page 132.
Figure 19. Overlooking upper-level windows.
Figure 20. Overlooked space: Loss of privacy in the outdoor space due to visual intrusion.
Figure 21. Metal or plastic partitions are used to create privacy: High partitions added to the outdoor property’s walls affect the architectural quality of the dwelling (Bahammam 1986).
Figure 22. Partitions between dwellings: Metal sheets have been used to block the view from the neighbors' windows (Bahammam 1986).

III. Privacy of the Outdoor Space
b. Dwelling Entrance and Loss of Privacy

The entrance way is the only connection between the dwelling and the street. It is the transition point between the external public domain and the domestic private domain.

In the traditional dwelling's design, the entrance to the inner space of the house from the outside is through an intermediate area which emphasizes the distinction between the external and the internal spaces. At the same time this area constitutes a filter which establishes a sequence of penetration through changes in direction. It is designed to obstruct any view of the inside and it does not give immediate access to the inner private space as shown in Figure 23 on page 46.

In the contemporary house, the transition between the private space of the dwelling and the street is designed only to be an access. It is not designed to protect the space from the gaze of passersby in the street. When the door is open there is no clear distinction between the private domain and the public domain. A passerby in the street can view the entire yard at a glance when the door is open as shown in Figure 24 on page 47. In traditional dwellings, the entrance is usually located at the furthest point of the dwelling while in contemporary dwellings, the entrance is located in the middle of the property and opens directly to "private" inner space.
Figure 23. Traditional dwelling's entrance way: The entrance way to the inner courtyard in the traditional dwelling provide privacy from the outside.
Figure 24. Contemporary dwelling's entrance: The contemporary entrance of the dwelling is open directly to the street without respect to outdoor privacy requirements (Municipality of Riyadh 1985).

III. Privacy of the Outdoor Space
D. Conclusion

The adoption of new municipal regulations, grounded in concepts foreign to Saudi culture, has produced a form of architecture which fails to satisfy the desire for privacy. The hierarchy of spaces; public, semi-private and private; in traditional house design does not exist in contemporary designs. The outdoor space might be physically protected, but it is certainly not visually protected. The visual invasion of privacy by the neighbors as well as from the street has affected the use, the shape, and the look of the outdoor space and made it less functional.
IV. Climatic Considerations

The physical environment consists of many elements in a complex relationship. One can try to describe the environmental constituents as: light, sound, climate, space and animate. They all act directly upon the human body, which can either absorb them or try to counteract their effects. Physical and psychological reactions result from this struggle for biological equilibrium. Man strives for the point at which minimum expenditure of energy is needed to adjust himself to his environment. Conditions under which he succeeds in doing so can be defined as the "comfort zone," wherein most of his energy is freed for productivity.

The shelter is the main instrument for fulfilling the requirements of comfort. It modifies the natural environment to approach optimum conditions of livability. It should filter, absorb, or repel environmental elements according to their beneficial or adverse contributions to man's comfort. Ideally, the satisfaction of all physiological needs would constitute the criterion of an environmentally balanced shelter (Olgyay 1973).
The human body exchanges heat with its surroundings can be classified into four main processes: radiation, conduction, convection, and evaporation as shown in Figure 25 on page 53. The factors involved in the heat balance of the body have been summarized to the following:

1. Heat produced by:
   a) Basal processes.
   b) Activity.
   c) Muscle tensing and shivering in response to cold.

2. Absorption of radiant energy:
   a) From sun directly or reflected.
   b) From glowing radiators.
   c) From non-glowing hot objects.

3. Heat conduction toward the body:
   a) From air above skin temperature.
   b) By contact with hotter objects.

4. Condensation of atmospheric moisture (occasional)

5. Outward radiation:
   a) To "sky".
   b) To colder surroundings.

6. Heat conduction away from the body:
   a) To air below skin temperature (hastened by air movement-convection).
b) By contact with colder objects.

7. Evaporation:
   a) From respiratory tract.
   b) From skin.

The actual relative magnitude of body heat production and heat interchange with the environment may vary within wide limits. The vital processes of the body are accompanied by considerable energy exchange (Olgyay 1973).

The principal climatic elements considered in human comfort and building design are solar radiation and air temperature, wind and humidity (Konya 1980). Other elements, such as precipitation, are not considered in this study because they do not have influence in the region. A successful design should relate and respond to climatic elements, especially when dealing with outdoor activities.

The traditional type of house and use of space evolved in response to the requirement for human comfort. The contemporary house was developed in response to the same needs but has been designed to rely on mechanical devices and systems to create human comfort inside the house with complete separation from the outside. As a result, the outside space is not utilized by people as it had been in the traditional house.

In this study, climatic criteria will be considered in evaluating the contemporary open spaces in the low rise dwelling. The design criteria which should be considered for domestic architecture in the hot dry climate is adapted mostly from Gary Robinette's book *Energy Efficient Site Design* 1983.
1. Reduce effects of daytime radiation, through
   a. Compact building forms,
   b. Optimum orientations, and
   c. Maximum shade;
2. Maximize humidity; and

Evaluating low-rise housing types by these criteria will give us the insight as to whether contemporary open spaces are successfully functional or not under existing climatic conditions.
Figure 25. Thermal exchange between human body and its environment: (Konya 1980).
Figure 26. Schematic comfort zone: This chart shows the comfort zone in the center. The climatic elements around it indicate the nature of corrective measures necessary to restore the feeling of comfort at any point outside the comfort zone. Adapted from Victor Olgyay, *Design with Climate*. 

IV. Climatic Considerations
Figure 27. Riyadh climatic zone: Adapted from *Riyadh Diplomatic Quarter*, Design Manual. It is noted that the Comfort Zone is starting at 3% relative humidity, while it is supposed to start at 20% relative humidity according to Olgyay's chart Figure 26 on page 54.
Saudi Arabia is a big country. It lies between latitude 18 degrees North and 30 degrees North. Most of the country is hot desert, so the climate is in the hot-dry zone, although coastal lands are subject to high humidity. Riyadh city is located in the middle of the country, on latitude 24 degrees North as shown in Figure 28 on page 57, at height of approximately 600 meters above sea level.

The characteristics of Riyadh’s climate include very high daytime summer temperatures, ranging from 26 - 45 degrees Celsius in the summer months, and combined with extensive solar radiation as shown in Figure 31 on page 60. There is, however, a great difference between summer and winter climate due to the changing altitude of the sun as shown in Figure 30 on page 59. Air temperature may fall as low as 0 degrees Celsius or less in winter with correspondingly shorter days as shown in Figure 32 on page 61.

In this climate, the sky is usually cloudless and clear. When there is a dust haze in the sky, it is very bright. There is little rain and a low vapor pressure (7.5 - 20 millibars and relative humidities often below 50 percent), but there are occasional flash storms where as much as 20 mm of rain may fall in an hour (Ministry of Agriculture and Water 1984).
Figure 28. Map of Saudi Arabia: Showing the location of the city of Riyadh (Ministry of Agriculture and Water 1984).
Figure 29. Sun path diagram for Riyadh (The American Institute of Architectural Standards 1982).
Figure 30. Seasonal Variations: Positions of the sun and Solar azimuth for Riyadh at 24 degree (The American Institute of Architectural Standards 1982).

IV. Climatic Considerations
Figure 31. Mean monthly solar radiation in Riyadh: Monthly mean and standard deviation of daily solar radiation in Langley's per day from 1975-80 (Ministry of Agriculture and Water 1984).

IV. Climatic Considerations
Figure 32. Air temperature in Riyadh: Annual Ranges (Ministry of Agriculture and Water 1984).
A. Radiation Control

Solar radiation, occurring in short wave-lengths, is the source of almost all the earth's energy and is, as a result, the dominant influence in all climatic phenomena. As the surface of the earth absorbs energy from direct short-wave radiation which passes through the atmosphere without being absorbed, the earth's temperature increases and it, too, radiates energy; though in this case with a long wave-lengths which can be absorbed by the atmosphere. As the atmosphere absorbs energy, its own temperature is raised and, in turn, radiates heat, some downward to the earth and some outward to be lost in the sky (Konya 1980).

Solar radiation varies greatly with the geographic location, altitude and season, length of day, angle of incident sun's rays to the ground, with the length and quality of atmosphere through which it passes, and particularly with the cloud coverage. In general, the greatest amount of radiation is found in two broad bands encircling the earth between 15 degrees and 35 degrees latitude north and south as shown in Figure 31 on page 60 for the mean monthly solar radiation.

The four main channels of radiant heat transfer affecting buildings are, in order of importance: direct short-wave radiation from the sun; diffused short-wave radiation from the sky-vault; short-wave radiation reflected from the surrounding terrain; and long-wave radiation from the heated ground and nearby objects as shown on Figure 33 on page 64.

The major form of heat transfer affecting outdoor open spaces is the outgoing long-wave radiation exchange from building to sky - an effect which is reduced when the sky is

IV. Climatic Considerations
clouded and is strongest when the atmosphere is clear and dry as in hot-arid zones. In
the hot climate areas of the world, it is particularly important that these effects are in-
fluenced (if not determined) by the designer (Konya 1980).
Figure 33. Radiation and heat exchange between the atmosphere and the ground: The passage of radiation through the atmosphere and the heat released from the ground (Konya 1980).
Figure 34. Explanation of the exchange of radiation and heat: In the arid zones a large percentage of the radiation reaches the ground (a); most of it however, is lost at night (b) (Konya 1980, p. 10).
1. Compact Building Form

In the hot areas of the world, people spend a great deal of their time outdoors, and as this is only possible when external spaces are shaded, the creation of comfortable conditions around and between buildings is extremely important (Konya 1980).

Outdoor conditions are so hostile in this climate, that both the buildings and the external living spaces need to be protected as much as possible from the intense solar radiation. By aligning buildings close to each other, mutual shading will decrease the heat gains on external walls and spaces. For this reason in hot-dry climates the tendency is to have close groups of buildings, narrow roads and streets, arcades, colonnades and small enclosed courtyards, in order to get the maximum amount of shade and coolness. as illustrated in Figure 35 on page 69 and Figure 37 on page 71.

It is necessary to treat the external spaces just as carefully as the building itself. Adjacent buildings, pavements and dry ground heat up quickly, causing both a painful glare and reflected heat radiation towards the building during the day, and at night they will re-radiate the heat stored during the day. Enclosure of out-door areas by walls which are themselves shaded will help to avoid such effects, and at the same time keep out dust and hot winds (Koenigsberger, Ingersoll, Mayhew, and Szokolay 1973).

The traditional open space or courtyard acts as an outdoor extension to the surrounding covered galleries and the rooms beyond them. The covered galleries, usually surrounded on four sides of the courtyard, help to reduce the quantity of heat gained during the day from direct solar radiation and provide shaded areas. As the height of the court is usually
greater than any of its dimensions, there is always adequate shading, even when the summer sun is almost directly overhead.

On the other hand, contemporary low rise dwellings have been built to function exactly the same way the traditional dwelling function, and serve the same people in the same environmental conditions. The only difference is that the new design does not adequately meet the environmental needs of people. The designers of the street system and the dwellings have not considered the influence of solar radiation. The modern street grid system in Riyadh, as shown in Figure 38 on page 72, opens huge gaps in the urban pattern to all kind of radiation especially direct short-wave radiation from the sun and long-wave radiation from the heated ground and nearby objects. Municipal regulations have played a major role in breaking the tight traditional urban pattern by separating buildings from each other. These regulations require that:

- A built-up area generally should not exceed sixty percent of the land area, including attachments.

- Front setback should be equal to one-fifth of the width of the road and should not exceed six meters.

- Side and rear setbacks should not be less than two meters and building projections should not be permitted within this area (Al-Hathloul 1981).

The application of these regulations separates buildings from each other, and creates unusable spaces with exposure to the harsh climate as shown in Figure 38 on page 72 and Figure 41 on page 78.
Outdoor space in the contemporary low rise dwelling is located around the solid mass of the dwelling as illustrated in Figure 41 on page 78. The municipal building regulations plus the Pattern and orientation of streets do not lend themselves to an urban pattern which allows mitigation of the influence of solar radiation. Because outdoor residential spaces are exposed to all kinds of radiation and tremendous amounts of heat, they are rendered unusable for human activities.
Figure 35. Typical hot-dry region settlement, Marrakesh: A compact urban form to protect from the outside harsh environment (Koenigsberger, Ingersoll, Mayhew, and Szokolay 1980, p. 204).
Figure 36. The thermal system of a courtyard house: (Koenigsberger, Ingersoll, Mayhew, and Szokolay 1980, p. 205).
Figure 37. Traditional compact urban pattern: The open spaces and the courtyards are protected from all kinds of radiation by the solid masses of the surrounding buildings (Bahammam 1986, p. 39).
Figure 38. Typical urban layout: The urban pattern is open and loose. Huge open spaces between buildings are not protected from direct radiation and very wide street intensify the effects of the solar radiation (Bahammam 1986, p.40).
2. Orientation

The orientation of a building can take into account climatic factors such as wind and solar radiation. The quantities of solar radiation falling on different parts of a building at different times should be considered in planning the orientation of that building. It has, however, been recognized that both radiation and temperature act together to produce the heat experienced by a body or surface. This is expressed as the "sol-air" temperature (Konya 1980), which includes three component temperatures:

1. the temperature of the outdoor air;

2. the solar radiation absorbed by the body or surface; and

3. the radiant heat exchanged with the environment.

Orientation and building shape can reduce radiation and sol-air temperature to a minimum in the overheated period (noon), while simultaneously allowing some radiation during the cool months or the under-heated period. In Olgyay's book Design with Climate, he describes a sol-air approach to orientation and building shape in which not only the radiation receipts are considered, but also the heat impact of the diurnal temperatures. In hot climates protection from solar radiation is particularly important during periods of excessive heat. Differences of as much as 3 degrees Celsius have been observed in a space between spaces of different orientation. Optimum orientation would reduce radiation to a minimum in the overheated period, while simultaneously allowing some radiation during the underheated period.
Design of spaces to protect people from excessive solar radiation requires scientific analysis, for each location and for each type of building. The solar heat gain depends on the angle of sun’s rays, the atmospheric deflection, and the duration of sunshine. Selecting the correct shape and orientation of a building can minimize the heat effect of the solar radiation. On the other hand, the exposure to winter sun in the mornings and afternoons is desirable so that warmth is absorbed and radiated during cold nights. Specific screening arrangement can be always used to accommodate this paradox (Riyadh Diplomatic Quarter 1978).

The best orientation of outdoor activities in Riyadh is north and north west which means the largest open space should be placed in the north and/or north west section of the lot and the solid mass of the building should be placed in the south and/or south east section of the lot as shown in Figure 39 on page 76. By this reorientation, the solid mass of the dwelling shades the outdoor space and blocks the sun’s radiation during most of the day. This is not often accomplished in most circumstances because of the municipal setback regulations, the main open space for the dwelling is usually in the front next to the street. By cancelling the setbacks regulations designer will have the hole lot to arrange the element of the dwelling to have a better orientation. In most cases not enough open space is left after applying the setback regulations because the majority of the dwelling lots range from 20 x 20 m to 20 x 25 m as illustrated in Figure 40 on page 77 and Figure 41 on page 78.

The other problem that interferes with optimal orientation is privacy. Saudi residents would prefer to have their outdoor activities in a poorly oriented private space rather than in a well oriented space with no privacy. Therefore, the orientation of open space is usually sacrificed for other more important considerations. But, by permitting window
openings from the second floor up, for the owner who wanted setbacks, or by applying the proposed regulations by SCET for controlling the window height of the upper floor windows and the depth of the setback as shown in Figure 11 on page 23, the privacy of the space will not be visually violated.
Figure 39. Optimum orientation for Riyadh: Hot Arid Zone: 25 degrees south East (Gary Robinette 1983).
Figure 40. Open space and building orientation: The surrounding open space of the dwelling is exposed to solar radiation from all sides.
Figure 41. Typical modern villa-type: The narrow strips around the house are the setback from the boundary of the land. The open space of the dwelling is the front because of the maximum setback regulations.
3. Shade

The impact of solar radiation on buildings in hot climates can be reduced by orientation, structure effective design, and also by adequate shading. Although it is not always convenient or economical to shade roofs or walls of a dwelling, outdoor spaces must be shaded to eliminate or reduce one of the greatest source of heat gain; direct solar radiation falling on the space.

As we have previously discussed, modifying building orientation has not been possible in many cases because of the existing lot size, municipal regulations, and the street orientation. The need for adequate shaded areas for outdoor activities is a very important issue. Various methods are available for shading the outdoor spaces. These methods include vegetation and horizontal devices.

a. Vegetation

Trees and vegetation form an intermediate layer between the earth's surface and the atmosphere. Their moderating effect of the site climate has already been referred to in the context of air temperature, humidity, radiation and air movement. By covering the ground with vegetation, the surface of contact is transferred to a higher layer and larger volume which is increased four to twelve times. In all hot and dry regions of the earth the beneficial climatic effect of even the lightest plant cover is of considerable help (Koenigsberger, Ingersoll, Mayhew, and Szkolay 1980, p. 37).

Vegetation affects radiation by blocking direct solar radiation and reducing heat loads of exposed surfaces. Vegetation shades and absorbs rather than reflects sun-
shine (Robinette 1983). Vegetation can also improve summer micro-climate by filtering and cooling the air and adding moisture as shown in Figure 61 on page 130 and Figure 42 on page 81.

Palm trees are the tree most frequently used in landscaping. Unfortunately, they are not the best kind of tree for shading because they do not provide as much shade as deciduous trees do. Typically deciduous trees reduce solar radiation up to 4 percent of the level in unprotected spaces, and air heat up to 25 percent (Robinette 1983). On the other hand, palm trees are evergreen trees which means that they block the sun’s rays when they are most needed in the cold winter.

Currently, most residential outdoor spaces have no tree cover or protection as shown in Figure 43 on page 82. When trees are used, they are usually planted either for their aesthetic quality or for their fruits, such as the palm tree. Neither the sun’s path nor solar angles are considered in the location of trees in residential open space as shown in Figure 45 on page 87.
Figure 42. Temper the outdoor spaces by shading: Trees and shrubs provide the simplest way of protecting from solar radiation. The temperature around buildings can be tempered or by creating the proper shade. Temperatures shown were recorded in a hot-dry climate when the air temperature was 42 degrees Celsius (Konya 1980, p. 35).
Figure 43. Typical modern villa-type house design in Riyadh: Outdoor spaces exposed to solar radiation with no trees to provide protection.
b. *Horizontal Shading Devices*

Horizontal structures are most effective against a high sun. The nearer one is to the equator, the easier it is to shade an outdoor space with an overhang. Overhangs are generally sufficient to protect the space from direct solar radiation and driving rain as shown in Figure 59 on page 126. The overhang is the best device to provide shade for the outdoor activities through-out the day (Konya 1980).

Riyadh is located at latitude 24 degrees north. The angle of the sun is vertical at noon on June 21, and almost vertical during the summer months. Overhang structures supply good shade from 10:00 am until 2:00 pm through out the summer when the angles (altitude) of the sun are almost vertical as illustrated in Figure 28 on page 57, Figure 29 on page 58, and Figure 30 on page 59.

Usually overhang provides a sheltered parking place for the car as shown in Figure 44 on page 84. The use of the overhang for shading other active areas is limited, despite its advantages in giving shade and providing privacy. An important concern in the design of overhangs is the use of appropriate building materials, This will be discussed in more detail in the next chapter.
Figure 44. The contemporary use of the overhang: Currently they are only used for shading the car parking (Municipality of Riyadh 1985).
B. Wind and Air Movement Control

In the desert conditions there are times when the temperature of the air is above skin temperature. The human reaction to this dry heat takes the form of an unpleasant parched throat and dry prickly skin, while the sand and dust which often accompany the wind make a film of dust over everything. These conditions can cause great discomfort and must be taken into account in designing outdoor spaces (Fry and Drew 1982, p. 12).

The normal skin temperature is between 31 and 34 degrees Celsius. As air temperature approaches skin temperature, convective heat loss gradually decreases. The blood will increase the skin temperature to the higher limit (34 degrees Celsius), but when the air temperature reaches this point, there will be no more convective heat loss. As long as the average temperature of an exterior surface is below skin temperature, there will be some radiation heat loss, but as the exterior surface temperature increases, radiation losses are diminished. Radiant heat from the sun or a hot body can be a substantial heat gain factor. When both the convective and radiant elements in the heat exchange process are positive, bodily thermal balance may still be maintained by evaporation up to a limit, provided the air is sufficiently dry to permit a high evaporation rate (Koenigsberger, Ingersoll, Mayhew, and Szokolay 1980, p. 44).

Air temperature and air movement are closely linked issues. "A fan or wind will assist in cooling provided that the air is below skin temperature and not moisture - saturated" (Fry and Drew 1982, p. 13). The influence of evaporation is important because it makes hot, dry air more comfortable up to the point where heat alone causes ills such as
heatstroke and intense fatigue, especially since the average temperature in Riyadh is over skin temperature throughout the summer.

Riyadh suffers from the nuisance of blowing sand and dust, which cause physical discomfort - irritation to the eyes, nose and throat and also cause a great deal of extra cleaning work.

In the existing physical environment, plant materials are very successful in reducing the effect of desert winds. Trees planted along the masonry fence of the dwelling are permitting a certain amount of air to pass through, while most of the air flow does not penetrate the site as shown in Figure 58 on page 124. The problem is that the distribution of trees in the open space is usually arbitrary as shown in Figure 45 on page 87. Sand, because of its tendency to bounce along the ground (saltation), can be effectively stopped in the same way. The penetration of dust, however, is more difficult to control. Trees can also give protection from most of the wind-borne dust if they are planted densely relative to the direction of the prevailing wind.

Physical features such as neighboring buildings, walls, and street widths which may influence air movement and cast shadows do not work very well in the contemporary physical setting. Buildings are not grouped together as shown in Figure 38 on page 72, open spaces are scattered around the buildings with no protection against hot air flow nor against sand storms, except where there are trees.
Figure 45. Planting trees in the open space: Planting trees in the open space is an arbitrary matter (Municipality of Riyadh 1985).
Humidity is one of the important factors influencing comfort. The humidity or the amount of water vapor that air can hold is a function of the temperature of the air. Warm air can hold more water vapor than cold air. At any temperature, the amount of vapor the air actually holds compared to the amount of vapor it could hold when it is saturated is described as the relative humidity.

Although temperature and humidity may differ throughout the world, comfort occurs at certain combinations of temperature and humidity. The comfortable range of temperatures is between 21 and 28 degrees Celsius (70 and 80 degrees F) and of relative humidity between 18 and 75 percent as shown in Figure 27 on page 55 and in Figure 46 on page 91. As shown in the figures the outdoor temperatures in Riyadh vary far below and far above this range, the relative humidity averages is far below normal and the evaporation rate is very high, especially in summer. Increasing relative humidity and reducing the evaporation rate through architectural solutions are very important to maintain people’s comfort.

In the traditional home style, humidity has been taken into consideration by controlling the evaporation rate in the outdoor space and increasing the humidity of the air. This being done by shading and planting the courtyard and by creating small pools or foun-

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1 Atmospheric humidity refers to the water vapor content of the atmosphere gained as a result of evaporation from exposed water surfaces, moist ground, and plant transpiration (Konya 1980, p.15).
tains. If water is not available for this use, large porous earthenware pots, placed in the middle of the courtyard and filled with water which seeps through the walls of the pot, moistens the outside and cools and humidifies the passing air as it evaporates.

Warm air passing over a body of water evaporates the water and, as a significant amount of heat is absorbed in the process, the air is cooled\(^2\). The evaporated water is retained in the air thus increasing its humidity; for this reason evaporative coolers can only be used in relatively dry climates. The same principal can be used by channelling breezes over pools or fountains. A fountain pond is more effective than a still pool of the same size and has an additional advantage that is not only cools the air but can also 'wash' it: the water droplets stick to dust particles in the air which can then no longer remain suspension as shown in -- Figure id ‘humid1’ unknown --. (Konya 1980, p.57).

The design of the contemporary outdoor space in Riyadh is completely open to the outside air and sun. It is a temperate climate design, not a hot arid design. In this design the evaporation rate can not be controlled nor can humid air be trapped as illustrated in Figure 48 on page 93.

\[D. \ \textit{Conclusion}\]

The new dwelling pattern with its adopted street system and zoning and setback regulations has created a set of problems for residents. The contemporary dwelling unit reverses the traditional design. Instead of having the open space in the center of the

\(^2\) Cooled through the process termed latent heat of evaporation.
dwelling, it is left outside, surrounding the dwelling form. The open space is no longer protected and sheltered by the dwelling’s structure, and is totally exposed to all kinds of radiation, high temperatures, and hot and sandy winds. Optimum orientation of building form is impossible in most cases because of the size of the dwelling lots, the planning system, and the zoning and setback regulations. Because of the lack and the misuse of vegetation, shade is almost missing, and there is no retention of humidity or moisture in the space. The design of the contemporary outdoor space has failed to meet the climatic needs of the residents in the region’s hot, dry climate.

(see Figure 48 on page 93 for the contemporary outdoor space.)
Figure 46. Relative humidity: Monthly ranges (Ministry of Agriculture and Water 1984).
Figure 47. Mean monthly pan evaporation: Accumulative mean monthly pan evaporation in Millimeters computed from integrated monthly values from 1975-80 (Ministry of Agriculture and Water, 1984).
Figure 48. An exposed outdoor space to the hot dry climate: The large outdoor spaces are exposed to the hot arid climate. No control of humidity is possible in the contemporary design.
V. Thermal Effects of Materials

To understand the relation between building materials and climate one must realize that the heat we receive from the sun is returned each day to the atmosphere and to the clouds. The sun sends out short-wave portion of the spectrum. The earth retains the received rays, some of which are also absorbed by clouds and dust. The surfaces which receive the sun’s rays undergo a considerably greater temperature change. This fact is of paramount important in the choice of building materials (Fry and Drew 1982).

It is customary to divide radiant heat transfer affecting buildings into five main components. In order of importance they are:

1. direct short-wave radiation from the sun;

2. diffuse short-wave radiation from the sky;

3. short-wave radiation reflected from the surrounding terrain;

4. long-wave radiation from the heated ground and nearby objects; and
5. outgoing long-wave radiation exchange from building to sky (Olgyay 1973).

\textit{Direct and Diffuse Solar Radiation (1) (2).}

Solar radiation is one of the most important natural contributors to heat gain in dwellings. Therefore, a quick and precise means of calculating the intensity of this radiation is of primary interest to architects.

The radiation passing through the atmosphere is "scattered" because of suspended dust and air molecules and because part is reflected diffusely from the clouds back into space. The transmitted energy will thus vary according to the distance the sun's beams must travel through the atmosphere. At noon when the sun is close to vertical and the distance is through the atmosphere is the shortest, the amount of energy received will be greatest. In early morning or late evening, when the atmospheric distance is greater, less energy will be received as shown in Figure 49 on page 97 (Olgyay 1973).

\textit{Radiation Reflected from Surrounding Terrain (3).}

Roughly twice as much solar energy falls on a horizontal surface during the overheated period, at noon when the sun the sun is close to vertical, surrounding horizontal surfaces reflect a good amount of heat onto buildings (Olgyay 1973). This heat flux can constitute a considerable load; the amount depends on the exposure and reflectivity of the immediate terrain. To reduce the impact of reflected radiation, it is desirable to surround a house with surfaces of low reflectivity. The architectural layout for such arrangements can be calculated by inverting the computation method for overhangs, since the angle of the reflected rays, however diffuse, will still correspond roughly to the angle of solar...
incidence as illustrated in Figure 49 on page 97 and in Table 1 on page 99 for the reflectivity percentages of various materials.

**Long-wave Radiation from Heated Ground (4).**

Near a building the ground and objects that are heated by the sun’s rays may rise to substantial temperatures. Observations in arid regions have found surface temperatures varying from 113 degrees F (with air temperature at 98 degrees F) to 144 degree F (with air at 116 degrees F) on clear summer days, the ground surface temperatures as high as 160 degree F have been reported (Olgyay 1973). Building walls exposed to such conditions gain appreciable heat as shown in Figure 51 on page 100 for the difference between the the air temperature and surrounding surfaces’ temperatures

**Outgoing Long-wave Radiation (5).**

Terrestrial heat balance implies that the yearly average of the total outgoing radiation from the earth and atmosphere is in equilibrium with the total incoming solar radiation. The outgoing radiation, however, is not uniformly intense; it varies with the seasons, and toward the poles it decreases about 10 to 20 percent (Olgyay 1973). Outgoing radiation can constitute an important channel for heat disposal in housing, especially in hot-arid regions. This possibility is neither adequately recognized nor significantly utilized in building practice as discussed in the next two sections.
Figure 49. Passage of radiation through the atmosphere: 5% reflected from the ground (a), 20% reflected from the clouds (b), 25% absorbed in the atmosphere (c), 23% diffuse, on the ground (d), and 27% direct, on the ground (e) (Koenigsberger, Ingersoll, Mayhew, and Szokolay 1980, p. 7).
Figure 50. Heat release from the ground and the atmosphere: 20% long-wave radiation (a), 20% evaporation, thence radiation (b), and 10% convection, thence radiation (c) (Koenigsberger, Ingersoll, Mayhew, and Szokolay 1986, p. 7).
<table>
<thead>
<tr>
<th>Nature of Surface</th>
<th>Estimate % Reflected</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bare ground, dry</td>
<td>10-25</td>
</tr>
<tr>
<td>Bare ground, wet</td>
<td>8-9</td>
</tr>
<tr>
<td>Sand, dry</td>
<td>18-30</td>
</tr>
<tr>
<td>Sand, wet</td>
<td>9-18</td>
</tr>
<tr>
<td>Mud, black, dry</td>
<td>14</td>
</tr>
<tr>
<td>Mud, black, wet</td>
<td>8</td>
</tr>
<tr>
<td>Rock</td>
<td>12-15</td>
</tr>
<tr>
<td>Dry grass</td>
<td>32</td>
</tr>
<tr>
<td>Green fields</td>
<td>3-15</td>
</tr>
<tr>
<td>Green leaves</td>
<td>25-32</td>
</tr>
<tr>
<td>Dark forest</td>
<td>5</td>
</tr>
<tr>
<td>Desert</td>
<td>24-28</td>
</tr>
<tr>
<td>Salt flats</td>
<td>42</td>
</tr>
<tr>
<td>Brick, depending on color</td>
<td>23-48</td>
</tr>
<tr>
<td>Asphalt</td>
<td>15</td>
</tr>
<tr>
<td>City area</td>
<td>10</td>
</tr>
</tbody>
</table>

Table 1. Percentage of incident solar radiation diffusely reflected. The table indicates the reflectivity percentages of various surfaces (Olgyay 1973).
Figure 51. Ground materials and outdoor temperature: The temperature of the outdoor can be tempered or aggravated by nature of the surfaces which surround them (Robinette 1983).
A. Solar Radiation and Ground Surfaces

The portion of solar radiation which reaches the earth raises the temperature of the ground. The amount of temperature depends of the latitude, the season, the slope of the ground, the hour of the day, and the nature of the terrain. During the daytime the highest temperature is always found at the boundary between the ground and the air. The temperature, in other words, increases considerably as one approaches the ground. At night, as result of the loss of heat by evaporation and the temperature decreases as one approaches the ground. A peculiarity of micro-climate, therefore, is that the closer one approaches the ground the more extreme it becomes.

The natural cover of terrain tends to moderate extreme temperature and stabilize conditions. Plant and grassy cover reduces ground temperatures and while they may be still further reduced by other vegetation, cities and man-made surfaces tend to elevate temperatures and reduce humidity. A fairly common mistake, which can have most unpleasant results in hot climate zones, is to place paved surfaces- which store up a great deal more heat and remain hot longer than unpaved or grass surfaces-close to the windows or outdoor active places of houses and other buildings. Not only do these paved areas add appreciable heat to the air layer near their surface, but they also radiate and reflect large amounts of heat into the surrounding spaces and buildings, possibly already uncomfortable conditions as illustrated in Figure 52 on page 102 (Konya 1980).
Figure 52. Building materials and temperature: The temperatures in and around buildings can be tempered by the nature of surrounding surfaces. Temperatures shown were recorded in hot-dry climate when the air temperature was 42 degrees Celsius (Konya 1980).
**B. Thermal Forces and Building Materials**

Solar radiation consists of visible (wave-length 0.3 to 0.7 microns) and short infra-red radiation (1.7 to 2.5 microns). By the time it falls upon a building, the sun's energy has been reduced by the atmosphere. Since this energy is concentrated near the visible part of the spectrum, the criterion of reflectivity is in approximate relation to color values. White materials may reflect 90 percent or more, black materials 15 percent or less, of radiation received. This reflectivity is called Albedo.

On the other hand, the thermal exchange with the surroundings consists of longer infra-red wave-lengths. The characteristics of materials in regard to long-wave infra-red heat reflectivity depends more on surface density and molecular composition than on color (Olgyay 1973, p. 113).

The thermal forces acting on the outside of a structure are combinations of radiation and convective impacts.

The radiation component consists of:

1. incident solar radiation reflected from the surface (Albedo); and of

2. radiant heat exchange with outdoor surroundings and with the sky in a form of outdoing long-wave radiation. This is also called emissivity.

The convective heat impact is a function of exchange with the surrounding air temperature, and may be accelerated by air motion.

V. Thermal Effects of Materials 102
Under warm and sunlight conditions, heat input will take place; and during cold periods, at night, or on surfaces surrounded by low temperature objects, the heat exchange will work negatively, resulting in increasing the temperature of the space.
<table>
<thead>
<tr>
<th>SURFACE</th>
<th>PER CENT OF REFLECTIVITY</th>
<th>PER CENT OF EMITTIVITY</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SOLAR RADIATION</td>
<td>THERMAL RADIATION</td>
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<tr>
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<td>98</td>
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<tr>
<td>Aluminum, polished</td>
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<td>92</td>
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<tr>
<td>Whitewash</td>
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<td>-</td>
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</tr>
<tr>
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<td>80</td>
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<td>Aluminum paint</td>
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<td>45</td>
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<td>Wood, pine</td>
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<tr>
<td>Asbestos cement aged 1 year</td>
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<td>5</td>
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<tr>
<td>Red clay brick</td>
<td>23-30</td>
<td>6</td>
</tr>
<tr>
<td>Gray paint</td>
<td>25</td>
<td>5</td>
</tr>
<tr>
<td>Galvanized iron, aged (oxidized)</td>
<td>10</td>
<td>72</td>
</tr>
<tr>
<td>Black matte</td>
<td>3</td>
<td>5</td>
</tr>
</tbody>
</table>

Table 2. Reaction of materials to solar and thermal radiation (Olgyay 1973).
C. Contemporary Materials and Climatic Effects

Contemporary dwellings are built out of a large variety of the new manufactured building materials such as concrete, steel and glass. Traditional building materials such as mud, wood and stone have been more or less abandoned. Reinforced concrete and cement blocks are the major construction materials in Saudi Arabia, however different kinds of exterior finishing materials are applied. For walls, these materials range from the most expensive imported marble to low quality exterior plaster (stucco). The exterior wall colors are usually light. The paving materials range from less expensive marble to regular outdoor cement tiles.

1. Materials and Outdoor Temperature

In hot climate areas, radiation striking an opaque surface may be absorbed or reflected. The color of a surface gives a good indication of its absorptivity for solar radiation which decreases, and the reflectivity increases, with lightness. In other words the darker the color of a surface, the higher its temperature will be raised by the absorption of solar energy. Color, however, does not indicate the behavior of a surface with regard to its emissivity or power to emit long-wave radiation and both black and white painted surfaces lose heat to the sky at night at equal rates (Konya 1980).

The use of both reinforced concrete and cement block as major construction materials in the contemporary dwelling, and the use of asbestos cement tiles as an outdoor finishing material have a major effect on the air temperature during the day and at night.

V. Thermal Effects of Materials
The concrete in general has a high capacity for absorbing heat from the sun as shown in Figure 53 on page 110 for the capacity of various materials to store diurnal heat).

The portion of solar radiation which reaches the dwelling structure raises the temperature of the surface. The exposed surfaces reflect some of the radiation in the form of either solar or thermal radiation into space. Exposed surfaces also absorb heat and store it. The amount of heat gain depends on the building materials. Concrete, for example, has a high capacity of absorptivity as shown in Figure 66 on page 137 for the absorption of heat by different surface materials and in Table 2 on page 105 for the reaction of different materials to thermal radiation.

As a result of the thermal forces on the outside of a structure the temperature increases considerably as one approaches the ground or the surrounding walls. In other words, during the daytime the highest temperature is always found at the boundary between the ground and the air. The dark-colored aluminum used as privacy partitions or as shading overhangs also raises air temperature of the outdoors.

As the sun goes down, the stored heat in the deepest level of the mass gradually returns to the surface. By the convection process and the effect of outgoing long-wave radiation, the stored heat is exchanged with the surrounding air temperature and surrounding objects. The heat exchange works negatively to retain heat in the space.

2. Glare and Daylight

One of the problem in hot climates is to exclude not only radiant heat but also glare, while at the same time admitting sufficient daylight. In the arid areas glare arises mainly
through sunlight being reflected from the surface of the ground and light colored walls of other buildings. A traditional way of overcoming this problem is by having the open space in the middle of the dwelling shaded and protected by the dwelling structure.

In the contemporary design of the dwelling, the outdoor space is exposed to the sunlight so, reflected glare from outside ground and other surfaces creates the problem. Also, the exterior finishing materials, which are used in the contemporary building, increase the glare by reflecting a high percent of the received sunlight as shown in Figure 54 on page 111. The increase of glare in the space causes a sensation of uncomfortable brightness and headaches in people who are outside during the day time.

**D. Conclusion**

In Riyadh, of building material performance is very important since there is a wide variation between day and night temperature. The choice of materials for outdoor spaces should take into account the heat variation between the the overheated and the underheated periods, and materials with suitable thermal characteristics should be used. Contemporary building materials, especially concrete, are not suitable for outdoor use because of their ability to absorb heat during the daytime and release it at night. The negative impact of the contemporary building materials results in destroying the function of the exterior spaces.

V. Thermal Effects of Materials
Figure 53. The diurnal heat storage capacity of various materials (The American Institute of Architects 1982).
Figure 54. Glare and outdoor space: In hot-dry areas reflected glare from the ground and other surfaces creates a problem in the outdoor space (Konya 1980).
VI. Discussion of Findings and Recommendations

I. Privacy of the Outdoor Space

As a result of the strong evolution of the Islamic teachings and the traditional social style, privacy in Saudi Arabia has become the determining behavior factor in shaping Saudi dwelling architecture. It is in many cases the standard to judge the success or the failure of the architectural design.

Saudi society insists on two specific forms of dwelling privacy established by the Islamic teachings. The two forms are:

1. Privacy between sexes, which is the total segregation between Muslim men and Muslim women in public and in private surroundings, unless the women and men are related by blood or marriage.
2. Privacy between dwellings and the outside, which is required to protect members of dwelling family, both men and women, from outside intrusion.

These two forms of privacy reflect the main purpose of the architectural space in Islam. As the human body is concealed behind its superficial appearance, clothing, gestures and behavior to protect his inner feelings and shape the architectural space should be protected from the outsiders and it should reflect his users behavior. The design of the domestic open space should provide total separation between private inside and public outside. By ensuring that, the privacy between sexes and the family privacy, in turn, will be ensured from any outside intrusion.

The contemporary detached outward oriented dwellings with domestic outdoor space surrounding the body of the dwelling has not provide the required level of privacy of the society. The privacy of the domestics open space has been violated in two ways.

1. Intrusion from above, which is a result of the application of the setback regulations the upper windows, balconies and terraces overlook nearby and adjacent properties and intrude into the private nature of the domestic life of the outdoor space of the neighbor's' dwellings as shown in Figure 19 on page 41, and Figure 20 on page 42.

2. Loss of privacy through dwelling entrance. The exterior door which is the direct transition between the private space of the dwelling and the street is causing that loss of privacy. When the door is open for any use, especially when the kids are running out and in to the street, a passerby in the street can view the entire domestic open space at a glance as shown in Figure 24 on page 47.
As a result of the loss of privacy of the domestic open space from above, by neighbors' windows, balconies and terraces, and from the street through the exterior door, the domestic open space has lost its characteristics as an outdoor family space. Two recommendations are proper for the existing conditions to provide the privacy of the outdoor space: first, protect the outdoor space from above; and second, ensure clear separation between the private inside and the public outside (street). By ensuring these two considerations the domestic open space will not have any privacy disturbance.

II. Climatic Considerations of the Outdoor Space

The principle climatic elements, when human comfort and building design are being considered, are solar radiation, temperature, humidity, wind, and precipitation. These elements act directly upon the human body, which can either absorb them or try to counteract their effects. Rarely, if ever, do all of these climatic elements have the same characteristics in different locations of the earth.

Riyadh is located in the middle of the desert of Arabia where the climate is in the hot-dry zone. The characteristic of Riyadh's climatic elements are:

- high amount of solar radiation,
- peak afternoon sun 3 p.m. Year Round,
- extended period of overheating and large diurnal temperature range,
• dry atmosphere and low relative humidity,

• sand-blown winds and dust storms, and

• low precipitation.

The basic idea of design is to provide the comfortable conditions without the use of expensive energy-consuming mechanical equipments, especially when dealing with the design of the outdoors, where the contact with the climate is direct. This is only possible, however, if climate is taken into account from the outset; if it is taken into account when deciding on the over-all concept, on the layout and orientation, and on the shape and character of structures among other things.

The physical pattern of the contemporary living environment is following a grid plan with a hierarchy of streets, rectangular blocks, and large lots which, in most cases, take a square shape. The contemporary house is the villa-type house which consists of the house, in most cases, in the middle of the lots with a large front yard, narrow strips of one to two meters around the house, and a narrow distance between buildings in the back. Unfortunately, the contemporary outward design of the domestic open space surrounding the house has not taken into account the local climatic elements. The large paved unprotected space add to increased direct radiation in daytime and outgoing radiation in the evenings. The large space scattered between buildings with no building or plant cover draws sand and dust in filtration, and losses atmospheric humidity very quickly.

The domestic open space in the contemporary set is a waste of space in the dwelling unit because it did not provide the needed protection from the harsh climatic elements. There
are objectives recommended to ensure and protect the space in the existing situation and provide the comfortable climatic conditions. These objectives deal with each aspects of the climatic elements and they are:

1. Reduce effect of daytime radiation,

2. minimize wind effects, and

3. maximize humidity.

These three concerns are the major issues by which we can have control over the local climatic elements which are solar radiation, temperature, humidity, wind, and precipitation.

III. Thermal Effect of Materials

The portion of solar radiation which reach the earth raises the temperature of the ground. The amount of heat gain depends on latitude, the season, the slope of the ground, the hour of the day, and mostly the nature of the terrain. The mature of the terrain or the surface materials play a very important role in tempering or aggravating the temperature of the surrounding.

The thermal forces acting on the outside of a structure are combinations of radiation and convective impacts. The radiation component consists of:
1. Incident solar radiation reflected from the surface (Albedo).

2. Radiant heat exchange with outdoor surroundings and with the sky in a form of outgoing long-wave radiation.

The convective heat impact is a function of exchange with the surrounding air temperature, and may be accelerated by air motion.

The exposed surfaces of the dwelling structure reflect some of the falling radiation in the form of either solar or thermal radiation into space. Exposed surfaces also absorb heat and store it. As a result of the thermal forces of the outside of a structure the temperature increases considerably as on approaches the ground or the surrounding walls. Glare also arises mainly through reflected solar radiation from the surface of the structure. As the sun goes down, the stored heat in the deepest level of the mass gradually returns to the surface. By the convective process and the effect of outgoing long-wave radiation, the stored heat is exchanged with the surrounding air temperature and surrounding objects.

The characteristics and color of surface materials are very important in controlling the thermal forces upon the structure in regard to absorption and reflection. Some building materials have a higher capacity of storing heat than other as shown in Figure 53 on page 110, while lighter colors have a tendency to reflect more than darker colors as shown in Table 2 on page 105.

Contemporary domestic open space is constructed out of large variety of new manufactured building materials such as concrete, steel, and glass. The large paved areas of the space using the new materials, the lack of trees and vegetation, and the bare concrete
walls add to increased temperature and glare in the daytime and heat radiation in the evenings as shown in Figure 51 on page 100, Figure 52 on page 102, and Figure 54 on page 111.

Two objectives have to be taken into account when choosing building materials. These are:

1. reduce thermal effects of the surface materials by:
   
   a. minimize the incident solar radiation reflected from the surface, and
   
   b. minimize outgoing exchange with the outdoor surroundings.

2. reduce glare, by
   
   a. minimize the reflectivity of the surface.
IV. Design Options

A. Clustering Building Around a Courtyard-Type Open Space

When the outward concept is adapted in designing and building houses, the yards in the front, the back, and the sides of the house become wasted space. They are exposed to the surrounding. The domestic outdoor space is no longer private because it is overlooked by surrounding houses as shown in Figure 19 on page 41 and Figure 20 on page 42, it is also no longer protected and sheltered against the existing climatic elements. It is totally exposed to all kinds of radiation, high temperatures, and hot and sandy winds as shown in Figure 48 on page 93.

Grouping building around courtyard-type open space is more than just a climatic and economic architectural solution, it is a architectural device for obtaining privacy as well as being an enjoyable extension of the house. as shown in Figure 18 on page 36. In the courtyard-type open space, the space is shielded by parts of the dwelling giving a complete protection from outside intrusion to the domestic privacy of the space as shown in Figure 56 on page 122 and Figure 55 on page 121.

Outdoor conditions are so hostile in Riyadh, that both the buildings and the external living spaces need to be protected as much as possible from the intense solar radiation and wind effects. By aligning buildings close to each other, mutual shading will decrease the heat gains on external walls an spaces. For this reason in hot-dry climates the tendency is to have close groups of buildings and small enclosed courtyards in order to get the maximum amount of shade and coolness as shown in Figure 57 on page 123.
The enclosure of outdoor domestic open space will stop the penetration of dust storms and sand-blown winds as shown in Figure 58 on page 124. The courtyard-type open space has also been used to retain humidity by controlling the evaporation rate in the outdoor space. This can be accomplished by providing shade and coolness to the space and by retaining the moisture from escaping as shown in Figure 64 on page 133.
Figure 55. Attach dwelling units: The cancelation of the rear and side setbacks allows to create a better design of the outdoor space (Municipality of Riyadh 1985).
Figure 56. Alternative design of the domestic open space: The courtyard-type open space provide privacy better than the outward looking design.
Figure 57. Alternative house design: Example of the courtyard-type dwelling which is better suited to the climate and the cultural needs, but unfortunately very rarely used.
Figure 58. Protection from hot air and wind-blown sand: The compact houses with courtyard-type open space are very effective in controlling the penetration of sand and dust. The depth of the space should not exceed 3 times the height of the barrier to be protected (Konya 1980, p. 72).
B. Horizontal Structural Devices

Horizontal structures are very effective against direct solar radiation. In Riyadh's climate, the best use of overhangs in the domestic outdoor space is on the south side because, as shown in Figure 30 on page 59, the sun is almost vertical throughout the summer months. Overhangs are generally sufficient to protect the space from direct solar radiation and driving rain as shown in Figure 59 on page 126.

Overhang devices are also recommended to ensure privacy of the existing domestic open space from the overlooking neighbors. By shielding the outdoor space with a horizontal latticework screen, the privacy of the space can be protected from the surrounding neighbors as shown in Figure 60 on page 127.
Figure 59. The use of the overhang for shading: Overhangs are the most effective against a high sun and normally used on the south side. It should exclude sun during summer and admit it in winter.
Figure 60. Use of overhang devices to provide privacy.
C. Use of Vegetation and Water Surfaces

In hot-dry areas the beneficial effect of even the lightest plant cover is quite considerable and the use of plant materials should be considered by the designer. Trees and other vegetation form an intermediate layer between the earth's surface and the atmosphere. Their moderating influence on air movement, humidity, solar and thermal radiation and wind is remarkable.

Vegetation provides a good protection from radiation by blocking direct short-wave solar radiation from the sun and long-wave radiation reflected from the surrounding terrains. Vegetation is the best shading device because it absorbs the solar and thermal radiation rather than reflects radiation as illustrated in Figure 61 on page 130, Figure 59, and Figure 52 on page 102. Figure 59.

Trees can be a very good device in controlling winds. In the contemporary domestic open space, trees planted along the masonry fence of the dwelling in the proper direction will permit a certain amount of air enough for ventilation to pass through, while they will cool hot air and filter and stop dust and sand from penetration to the site as noted in Figure 62 on page 131. Planting trees along the neighbor's sides could provide a good protection for the privacy of the domestic open space from overlooking neighbors as shown in Figure 63 on page 132.

The use of vegetation with existing of water surfaces such as small fountain, can increase the atmospheric humidity of the outdoors as illustrated in Figure 64 on page 133. By cooling and moisturizing the surrounding air, shading the space, and retaining humidity.
the domestic open space will be more convenient and more comfortable for human use and interaction.
Figure 61. Trees and degree of absorption: Trees can reduce air temperature to 25 percent and reduce solar radiation and glare to 4 percent (Robinette 1983, pp. 22-24).
Figure 62. Controlling wind effects by trees: Trees are very effective in controlling the penetration of hot air and wind-blown sand when planted in the right place and the right direction.
Figure 63. The use of trees for providing privacy: Planting trees along the neighbors' sides will protect the outdoor space neighbor's intrusion.
Figure 64. Controlling air humidity: Shading, planting, and creating moist or water surfaces are to maintain humidity at a comfortable level in the space.
D. Entrance to Property

The entrance to the property is the main connection between the dwelling and the external public domain and the domestic private domain. It is an intermediate channel that separate between two different domains with different characteristics and activities.

To prevent the interference between the two domains, the entrance should be an intermediate area that constitute a filter which establishes a sequence of penetration through changes in level of directions. The change of direction in the entrance way may involve opening the door to a screen which breaks direct vision by a passerby in the street into the house. This screen may be a wall, trees, or shrubs built or planted to serve this function alone as shown in Figure 65 on page 135, and Figure 66 on page 136.

It is recommended that the design of the entrance to the property should obstruct any view of the inside and it should not give an immediate access to the inner private domestic open space as illustrated in Figure 23 on page 46.
Figure 65. Some solutions for the outdoor main entrance door. To protect the privacy of the space from the street.
Figure 66. Trees could be used to break the direct vision of passerby in the street from viewing the private space.
E. Use of Color and Materials

Two factors in hot climates need to be considered when choosing building materials especially for the outdoor structures. These factors are the characteristics of the materials to absorb and radiate heat and their characteristics to reflect radiation. Consideration of these factors will ameliorate radiant heat and glare from the outdoor space.

The natural cover of terrain tends to moderate extreme temperature and stabilize conditions. Plant, grass and even bare ground reduces temperatures and glare, while man-made surfaces tend to elevate temperatures, increase glare, and reduce humidity. A fairly common mistake, which can have unpleasant results, is to place paved surfaces, in the outdoor space, which increase glare in the space by reflecting a high percent of the solar radiation falling on them and also store up a great deal more heat and remaining hot longer than unpaved or grass surfaces as shown in Figure 52 on page 102 and Figure 67 on page 138.

It is recommended when designing the outdoor spaces to use natural surfaces such as shrubs, grass, gravel, and bare ground. When choosing construction materials, avoid bright color materials because they reflect a high percent of radiation. Also the characteristics of the materials should be checked in regard to absorption as noted in Figure 53 on page 110.
Figure 67. The characteristics of different surface materials: Different surfaces behave differently in regard to absorption and reflection of heat - paving (a), grass (b), and bare ground (c) (Konya 1980, p. 35).

VI. Discussion of Findings and Recommendations
<table>
<thead>
<tr>
<th>Design objectives and Guidelines</th>
<th>Normal effects of materials</th>
<th>Climate Considerations</th>
<th>Privacy</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Reduce internal temp.</td>
<td>Increase humidity</td>
<td></td>
</tr>
<tr>
<td></td>
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<td>Shade:</td>
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<td></td>
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<td>Optimum orientation</td>
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<td></td>
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<td>Compensate building</td>
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<td></td>
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<td>Enhance privacy</td>
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<tr>
<td>Design courtyard-type open space</td>
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<td>Permit window openings from the second floor up</td>
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<tr>
<td>Plant trees in the right direction and place</td>
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</tr>
<tr>
<td>Use overhang devices</td>
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<tr>
<td>Provide water surfaces</td>
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<tr>
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<td>Use materials with low-capacity of absorbing heat</td>
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Table 3. The relation between the design objectives and the design options or guidelines.
VII. Conclusion

Open architectural spaces take different forms and sizes from one environment to another according to physical and social factors. Different forms of architectural open spaces exist in different parts of the world despite similar physical conditions. This variety in architectural forms is a reflection of man's ability to consider other factors beside the simple need of physical shelter.

The harsh climatic environment and the strictly observed religious requirement for privacy in Saudi Arabia make it impossible to enjoy unprotected outdoor spaces. The traditional open space, for centuries, has provided for privacy and climatic protection. Its successful design acted as an outdoor extension of the surrounding elements of the house. It was the most important element in the dwelling because of the livable environment which it created.

In the last four decades, and as a result of the rapid development of the country, grid street patterns and detached villa-type dwellings were introduced to Saudi Arabia. The new dwelling design presented a new physical and urban pattern, completely foreign to
the local environment. It introduced an outward looking type of dwellings more open to the outside than to the dwelling itself. This concept has been enforced by zoning and setback regulations. Adoption of the new development model has created a conflict between the architectural outdoor design and the physical and social needs of the residents.

The main goal of this thesis was to examine the conflict between the outdoor space available in contemporary low-rise dwelling units and the actual needs of their residents. I studied the contemporary outdoor space and its ability to satisfy the cultural and religious desire for privacy in Saudi society, as well as its ability to moderate the climatic characteristics of the region. The study presented this conflict in an effort to help professional designers avoid repeating the same problem in the future.

Since primitive man began establishing shelters, several things have changed greatly. The most important change is the builder’s ability to consider other factors over and above the simple need of physical shelter. Of these factors, privacy emerges as a significant element affecting design.

In Saudi Arabia, cultural and religious values have existed and been applied for many centuries, to protect the right of privacy. Islam establishes clear rules ensuring the right of privacy for individuals and groups. Because of its strong social role, privacy has become the determining factor in shaping Saudi architectural space.

The traditional courtyard was placed in the middle of the dwelling to ensure the required privacy level. The design reflected people’s behavior. As the human body is concealed behind superficial screens of appearance, the courtyard is protected by the structure of the dwelling.
The contemporary open space does not consider the essential values of Saudi society. The outward looking type of housing does not draw a clear line between the public and the private. The hierarchy of spaces; public, semi-private and private in the traditional house design, is missing in the contemporary design of the open space. Space, supposed to be private, is visually invaded from the outside. This intrusion negatively affects the use, the shape, and the look of the contemporary outdoor space in Saudi Arabia.

The effect of the local environment on the traditional way of living and building must be considered, especially if dealing with outdoor spaces. The indoor environment could be easily controlled through either architectural solutions or mechanical devices or control systems. The direct contact and relation between the outdoor space and the climate makes it very important to manipulate and adjust the design to provide the most comfortable environment.

For the local climate in Riyadh, specific climatic criteria can be applied to drive appropriately designed open space. The reduction of solar radiation, minimization of wind effects, and maximization of humidity are three major climatic considerations in the region’s hot, dry climate. These considerations have been provided for very carefully in traditional courtyard design. The enclosed form of the dwelling provides the needed shade for the courtyard, prevents the cool air and the relatively humid air from escaping, and shelters the space from the hot, sandy summer winds. It was designed to maintain comfort against the harsh local environment.

The contemporary western design of the dwelling unit reverses the traditional design. Instead of having the open space in the center of the dwelling, it is left outside, surrounding the dwelling form. The new dwelling pattern with its adopted street system and zoning and setback regulations has created the problem. The open outdoor space is no
longer protected and sheltered by the dwelling’s structure, it is totally exposed to the climatic elements such as solar radiation, high temperatures, and sandy winds. Because of the lack of vegetation, shade is almost absent, especially at noon when the sun is vertical, and there is no retention of humidity or moisture in the space. Optimum building orientations are impossible in most cases because of street’s planning system and zoning and regulations. The contemporary open space does not meet the climatic needs of the people in the region; therefore, the open space is unusable.

Material performance has to be considered in building in a hot climate. The capacity of building materials to deal with climatic elements is very important. The outdoor temperature can be tempered or aggravated by the nature of surrounding surfaces. The contemporary building materials used for outdoor surfaces in Riyadh are not suitable because of their high capacity to absorb heat during the daytime and release it at night. The negative impact of contemporary building materials results in creating uncomfortable climatic conditions for outdoor interactions.

The contemporary open space in low-rise dwelling units did not come as a direct response to the Saudi people’s needs and ethics. The adoption of western planning patterns, dwelling designs, zoning regulations, and building materials has produced architectural spaces neither psychologically nor physically suited to the Saudi environment. Neither privacy nor climate is considered in the new design of the dwelling open space. In other words, the contemporary outdoor space is an inadequate response to the climatic needs of the region and to the cultural needs of Saudi society. This study presents a new look at the outdoor space as an active liveable space, not just a leftover garden. Many of the professional designers in Saudi Arabia have not lived in a traditional house with a functional courtyard so, they do not recognize its importance to the
people. Hopefully, this study will serve as a useful design tool that can be used to help in improving the existing dwellings' outdoor design by recognizing their existing problems and can offer guidance to designers to avoid repeating the same inappropriate designs.
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_King Saud University_ (formerly Riyadh University), Riyadh, Saudi Arabia. B.S. in architecture, May 1984.

Professional Experience:

- Graduate Teaching Assistance, Landscape Department, College of Architecture, Virginia Polytechnic and State University, Fall 1988.
- Attended the International Federation of Landscape Architects 25th World Congress in Boston, Massachusetts on July 16-19, 1988.
  
  To provide information on the benefits of vegetation in relation to erosion control, temperature control and energy conservation, and amenity value.
  
  To provide information useful in protection, installation, and maintenance of vegetation.

- Designed the Blacksburg Water Path, for Blacksburg Planning Department, Blacksburg, Virginia, 1986.
- Developed a landscape design for Pembroke Apartments an adaptive re-use project providing low income housing for the elderly in Rural Southwestern Virginia, 1986.
- College of Architecture consultant for the new campus of King Saud University.
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