PROBLEMS AND SOLUTIONS chapter 1

the border region / la franja fronteriza

Aerial view of the Sonoran Desert along the Arizona/ Sonora line. The land knows no boundaries. The desert has a stark, desolate beauty, yet can be deadly for those trying to cross on foot. Photo: B. Vint

THE BORDER REGION *LA FRANJA FRONTERIZA*

The U.S./Mexico border is among the world's longest, stretching over 1,500 miles from San Diego to Brownsville, from Tijuana to Matamoros. This imaginary line both divides and unites two great countries, cultures, and peoples: those of the United States and Mexico.

The border separates Baja California, Sonora, Chihuahua, Coahuila, Nuevo León and Tamaulipas from California, Arizona, New Mexico and Texas. The geography includes the mountains and plains of the Sonoran and Chihuahuan deserts, and extends from the Pacific Ocean on the west to the Gulf of Mexico on the east.

The climate is predominately hot-arid, with summer daytime temperatures exceeding 110º F and yearly rainfall averaging less than 12 inches. Mountainous areas along the border are above the frost line, experiencing cold winters as well as hot summers. Along this line one of the world's most highly developed countries meets a nation still in development. This contrast creates intense urbanization in the border cities, particularly on the Mexican side, as millions of people move north in search of work or seeking to cross the line *al otro lado*: to the other side. On the U.S. side many families in rural areas continue to live in poverty.

What a U.S. Citizen would call the southwest is, for a Mexican, the far northwest. In comparison with the central and southern parts of Mexico the northwest is an arid wasteland. This contributes to disaster when people from the south attempt to cross the northern deserts, not understanding the scarcity of water and the effects of the rapid dehydration which occurs in the intense heat of the desert.

Some who come north stop at the border and find work in *maquiladoras* (the so-called twin plants). Some cross seasonally to work in agricultural fields, harvesting lettuce, tomatoes, peppers and citrus. Others use border cities as stopping points on their journeys north and south, meaning that these cities have a fluctuating population of migrants.

There is a shortage of adequate affordable housing to accommodate this influx of immigrants, and many people are living in crowded, unsanitary conditions on both sides of the border. This study examines the traditional architecture of the region, looking not only at problems, but also at how people have built successfully in the past as an example for the future.

LAS COLONIAS

On the Mexican side of the international line the result of rapid and unregulated urbanization can be seen in over-crowded, cluttered cities such as Tijuana, Nogales, Agua Prieta and Ciudad Juarez. In these cities houses are often built by their owners using salvaged materials: scraps of wood, cardboard, factory pallets and corrugated tar paper. Groups of these houses form shanty towns, know in Spanish as *colonias*.

In central Mexico's well-established cities, a *colonia* is simply a neighborhood. There are many wealthy colonias in Mexico City: Colonia Roma, Colonia del Valle, Colonia Condesa. Along the northern border, however, the word has taken on a new meaning. Colonias here are the squatter's settlements which appear overnight on the outskirts of towns, built by newcomers for whom there is no housing.

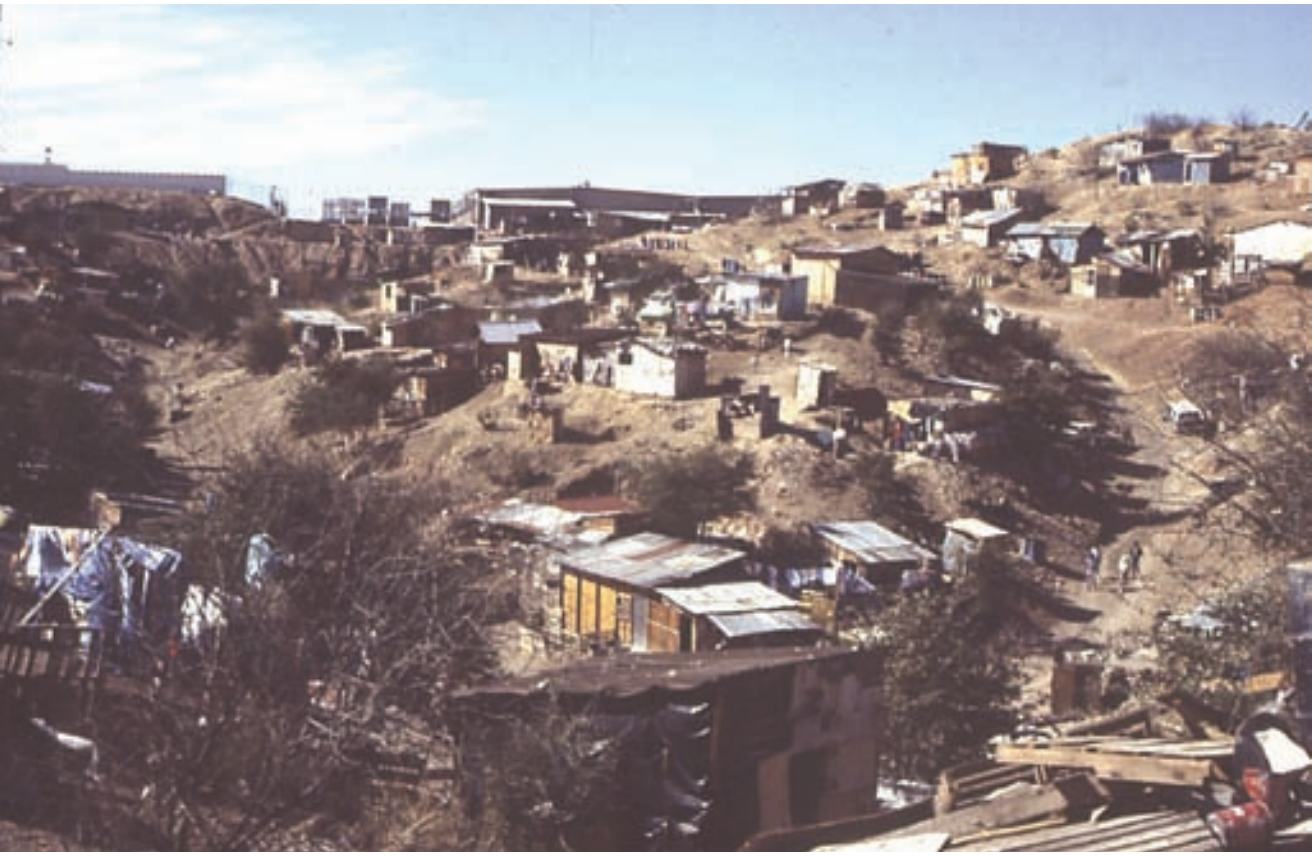
Colonias result from *invasiones* (invasions) in which squatters (popularly called *paracaidistas* -- parachutists -- because they suddenly appear as if they've fallen from the sky) move in under cover of darkness and build on land owned by others. The colonias lack the basic urban infrastructure of potable water, sanitary sewer, electricity and roads.

Colonia in Tijuana. The houses of paracaidistas (squatters) are built on marginal land at the edge of town, hilly, inaccessible and hard to build on. Shacks evolve by piecemeal replacement with permanent materials (cinder block and concrete). Gradually the colonias become permanent neighborhoods, as electricity and roads are added. Photo: A. Vint

AMBOS NOGALES *BOTH NOGALES*

South of Tucson, Arizona, are the twin border cities of Nogales, Arizona and Nogales, Sonora. Ambos Nogales (Both Nogales) were founded as an international railroad crossing in the 1890s. By the time of the Mexican Revolution (1910 – 20) the two towns had only a couple thousand inhabitants between them. In 1960 Nogales, Sonora had a population of 30,000 while Nogales, Arizona had half that amount. By 2004 Nogales, Arizona has grown to 20,000 inhabitants, while Nogales, Sonora is home to over 400,000 people – more than twenty times the size of its neighboring town on the U.S. side. This represents an urban expansion of over one thousand three hundred percent (1,300%).

There are more than 75 maquiladora factories in Nogales, Sonora, employing over 30,000 workers. The maquilas, or the so-called twin plants, employ Mexican workers at a fraction of U.S. wages in the assembly of components for duty-free re-importation to the U.S. On the U.S. side are row upon row of warehouses where the assembled goods are stored awaiting shipment. On the Mexican side are the factories, and the colonias that house the work force.



Colonia Los Tápiros, Nogales, Sonora. Maquiladoras are located at the top of the hill, with semi-trucks beside them waiting to carry finished products north. Worker's housing sprawls outside the factory fence. Photo: B. Vint

The colonias, for all their squalor, represent affordable housing to those who build and dwell in them. With no rent or mortgage to pay, housing is free – leaving what money is available to meet other needs of the family, such as food, clothing, fuel, medicine, and school supplies. Colonias are often located near factories, meaning that transit is not a great necessity. While crowding has serious drawbacks (lack of privacy and sanitation to name but two), it also encourages social interaction. There are many neighbors living close by, often extended family members, who provide a social support group in matters of day-to-day life: watching children, helping with chores or house raisings, support during crises, and so on.

Although many colonias are surprisingly vibrant communities, the inadequacy of shelter takes its toll in many ways, from illnesses due to contaminated water (dysentery and hepatitis) and the lack of weather-tight houses (chronic bronchitis, pneumonia, flu and colds), to deaths each winter from asphyxiation or fire due to using gas burners or wood fires to heat combustible shacks.

Despite the poverty and ugliness of the colonias, people who find no alternative than to build and live in them yet attempt to create beauty. Often the humblest shack has a small patio with flowering potted plants, as a family attempts to transform a small part of the outdoors into a micro climate of fresh air and greenery. The patio or courtyard is a Latin concept that can be traced back to Spain, Morocco and ancient Rome. To find this Mediterranean design idea alive and well in border shanty towns is a testament to the strength of culture, even under great distress. The courtyard is an essential concept for the design of new affordable housing for the border region.

Beauty amidst the chaos: a private patio in a hillside house in Tijuana. The traditional courtyard employed in a modest dwelling in a colonia. Photo: B. Vint

Colonia Los Tápiros, Nogales, Sonora. Photo: B. Vint

Colonia culture has crossed the border into the United States, along with subsistence-level immigrants. U.S. colonias are often unregulated rural communities of substandard manufactured housing, rather than the dense urban squatter settlements of the Mexican border cities. HUD defines a colonia as a residential area lacking potable water and/or sanitary sewer, and having an unsafe or inadequate housing stock. This definition fits numerous areas along both sides of the international line. U.S. colonias are usually settled by recent Mexican or Central American immigrants working in agriculture, and are seen as an extension of border colonias as they evolved in Mexico, spreading along the entire border.

Unregulated aggregations of mobile homes, such as *la Perra Flaca* north of Douglas, Arizona, are typically set up as farm labor camps on farmland rented to immigrant workers. In these cases there has been no review by planning authorities, and no formal subdivision process involving engineering of roads and utilities. They are generally without sanitary sewer connections, often with septic tanks and leach fields, and occasionally with only cesspools. Water is supplied from private wells or delivered by private water companies, and is of dubious quality. Lot boundaries are ill-defined.

Innovations in manufacturing and design continue to increase the market share of mobile homes. The efficiency of the assembly line outstrips the inherently inefficient nature of site-built houses. Mobile homes realize the promise of modern architecture: houses can now be mass-produced like cars or washing machines.

Factory methods require lightweight frame construction so that finished units or wall and roof panels can be transported to erection points. Frame construction in desert climates is at a disadvantage, for it has minimal thermal mass. Wood frame construction is also susceptible to termites and rot, reducing its longevity and increasing its life-cycle cost.

Traditional desert houses the world over have thick earthen or stone walls to moderate the extreme climate. Small, deeply recessed openings reduce the glare from the intense sun. These responses to the desert environment have been overlooked in recent practice. Frame/stucco is expedient, quick to erect and therefore less costly than adobe. It is however more costly to heat and cool. Without massive walls to stabilize the desert's temperature extremes -- 105° days followed by 60° nights -- the fluctuations of day and night temperatures make it necessary to run mechanical air conditioning to maintain comfort.

COLONIAS IN THE U.S.

"Colonia" mobile home park outside Yuma, AZ. Photo: B. Vint

As in the Mexican examples, unplanned mobile home parks evolve into permanent neighborhoods as people add on.
Photo: B. Vint

USDA sponsored affordable housing subdivision in Yuma, AZ. The designs are conventional detached suburban houses.
Photo: B. Vint

In Chapter 4 of this study the effects of thermal mass are analyzed through energy modeling to quantify their benefit in terms of comfort and energy conservation, in contrast with a base-case example of a wood-frame manufactured home.

Affordable housing subdivisions using conventional designs and frame/stucco construction have produced low-density suburban environments as seen in the photo at lower right. While technically adequate, this type of housing lacks regional appropriateness in both environmental and cultural senses.

Despite their differences, both sides of the border share a common culture of minimal housing for workers and their families. In the design of new affordable housing, architects, planners and administrators -- that is, the decision makers of community development -- must consider not only first costs, but life-cycle affordability in terms of energy and maintenance costs, as well as cultural factors such as house form and community space.

Plaza Zaragoza de Ures, Sonora A successful urban space in northern Mexico. Photo: B. Vint

Tucson, AZ Typical contemporary subdivision. Photo: B. Vint

CONTEMPORARY SOUTHWESTERN HOUSING

Tohono O'odham wa:tho (ramada) built of mesquite posts and ocotillo cactus stalks. The shade structure captures the essence of desert architecture. Photo: B. Vint

Over the 20th century the population of the Southwest has grown by a factor of 100, representing an increase of 10,000%. The great majority of population growth came after World War II. Initial urbanization was driven by the regional military bases which brought recruits through the Southwest for training or on their way to the west coast for deployment to the Far East. Many young soldiers were impressed by the warm winters, the clean, dry air, and the beautiful natural setting, and brought their families out during the post war baby boom. Currently, retirees escaping the harsh winters of the east or mid-west are moving to the Southwest in large numbers. There is an increasingly aged population.

This rapid growth is typical of sun belt cities including Albuquerque, El Paso, Phoenix, Tucson and Yuma. There has been a continual strain on the housing stock and a chronic lack of affordable housing for young families, working people and recent immigrants. A look at the southern Arizona city of Tucson presents a case in point of the southwestern housing crisis.

The lack of adequate affordable housing is a pressing problem in Tucson as elsewhere. The City of Tucson Department of Community Services estimates that over half the households in Tucson are unable to purchase market-rate housing, yet they can address only a fraction of this need.

SAN XAVIER DISTRICT, TUCSON

San Xavier District Tohono O'odham Nation, Tucson. The mobile home has little thermal insulation and no thermal mass, so that it becomes super-heated in the summer. Note evaporative cooler ("swamp box") on roof. Photo: B. Vint

Conventional frame & stucco affordable housing at San Xavier District. Note the thin walls, which are unable to moderate the heat and glare of the desert sun. This type of house requires air conditioning to remain comfortable, resulting in high utility bills for families who often cannot afford them. Photo: B. Vint

Traditional early 20th century Tohono O'odham extended family housing cluster at San Xavier District. Note adobe walls, minimal wall height and small size of houses. Photo: B. Vint

The city of Tucson, Arizona, is composed of many culturally distinct communities. Tucson's earliest inhabitants, the *Tohono O'odham* (Desert People), are today recognized as the Sovereign Dependent Tohono O'odham Nation. The San Xavier District of the Nation is located southwest of the city center and remains a rural village 300 years after the arrival of the Spanish. The O'odham are traditionally a rural people, and never developed urban architecture. They live in informal clusters of houses in the desert based on kinship structure.

The O'odham first built pit-houses or *ki*, domed shelters of brush and mud partially sunken into the ground. Next to the *ki* stood a *wa:tho* or arbor (*ramada* in Spanish) to provide shade. Much of the time the O'odham lived outdoors. The *wa:tho* is the essential desert architectural form, providing both shade and cross ventilation.

In 1693 Spanish missionaries reached southern Arizona, introducing adobe bricks and the resulting rectangular house form. Today the mobile or manufactured home is the most frequent affordable housing choice of tribal members. Second to this is the Federally funded tract home, built by professional contractors using conventional materials.

Economically the Tohono O'odham are among Tucson's least advantaged populations. There is a continuing need for affordable housing on the District. Given the rural tradition of the Tohono O'odham, this is an environment in which a detached rural affordable house-type appears to be an appropriate solution.

S. Meyer Ave, Barrio Viejo, Tucson: adobe row houses in the Sonoran tradition, ca. 1870 Photo: B. Vint

In the 19th century, the descendants of Tucson's Hispanic settlers built much as their Sonoran counterparts did in Ures, Aconchi and Arizpe: simple, massive houses with thick adobe walls, placed close to the street, and with gardens or courtyards behind or inside the houses. This is the traditional architecture of southern Spain and northern Africa, of Andalucía and Morocco, brought to a part of the new world with a very similar climate. It is a pedestrian-based vernacular, belonging to the pre-automobile era. Nonetheless it holds lessons for today's planners and architects, in the realms of environmental design and urbanism.

South of Tucson's central business district is a four-block square of Hispanic urban architecture, known as Barrio Viejo. It is what remains of a much larger neighborhood that was demolished in 1970 to make way for a place called the Tucson Community Center. Over half the old Barrio was destroyed during urban renewal. More than 200 adobe buildings were lost. In the spirit of their time, city planners wished to re-make Tucson as a "modern, forward looking city," rather than preserving the historic center. This is now widely recognized as an error.

The urban planners of the early 1970s intended to demolish the entire Barrio and rebuild in a modern image, but budget limitations prevented them from executing their entire plan. Therefore there remains some surviving Sonoran architecture to instruct us in the ways of urbanism.

In Tucson there yet remain streets lined with adobe houses, creating courtyards, micro climates, oases in the desert. With houses placed close together or sharing walls, a relatively high density was achieved despite the fact that the houses are generally only one story in height. The types of housing found in Barrio Viejo - the row-house, the zaguán house and the courtyard house - are explored in detail in *Ch. 2* of this study.

Mural of Barrio life by Francisco Franklin. Photo: C. Neumann

BARRIO VIEJO, TUCSON AZ

S. Meyer Ave., Barrio Viejo, Tucson: Transformed Sonoran rowhouse. Built ca. 1870 as a simple adobe box, a hipped roof was added in the late 19th Century. Photo: C. Neumann

S. Meyer Ave., Barrio Viejo, Tucson:
Courtyard as outdoor room.
Photo: B.Vint

S. Convent Ave., Barrio Viejo, Tucson:
Courtyard creates cool micro climate.
Photo: B.Vint

With the arrival of large numbers of Anglo immigrants in the early 20th century, and the advent of the automobile, Tucson's architecture changed dramatically. The detached house, reflecting Anglo traditions imported from the eastern United States, became the predominant model of development. Streets became much wider to accommodate cars and to attain privacy between the houses. The gridiron pattern of streets was begun, which now extends to all ends of the city. This represents the beginning of the lower density development which now typifies Tucson and much of the Southwest as well.

Although this type of urbanism may not be ideal for the desert, the early Anglo-traditional houses built in Tucson were well-adapted to the climate. Indeed they had to be, that people might comfortably live. The preferred house type was the bungalow, featuring a deep shady porch and wide overhanging eaves. Houses were built at the center of their lots, leaving space on all sides for vegetation. This is the striking difference between the Hispanic and Anglo traditions: the Hispanic house is inward-looking to a courtyard, while the Anglo house looks outward.

Within the overall city of Tucson, early 20th century Anglo development has a humane scale and a vernacular expression. Houses of a vernacular concept were built one or two at a time by small builders and developers, so that a variety of house types is represented. There is authentic individuality to these early neighborhoods, which is lacking in much of the housing that followed in the expansion of the post-World War II years.

WEST UNIVERSITY NEIGHBORHOOD, TUCSON

Bungalow in West University, Tucson. This type of house responds well to the climate, and has a pedestrian oriented presence on the street. Photo: B. Vint

Since 1945 Tucson has expanded rapidly on the basis of sun belt migration and automobile ownership, resulting in sprawling suburbs of predominately single story detached houses often connected by six lane roads to move traffic amongst them. Since 95% of Tucson has been built since the end of World War II, the great majority of the built environment is characterized by this type of development.

In a desert environment such as Tucson, low density development is inherently inefficient in its use of land and the public investment in infrastructure required to support it.

SUBDIVISIONS

Sprawl development outside Tucson, Arizona. Photo: B. Vint

Wood-frame house sheathed in foam awaiting synthetic stucco coating. Glue-on foam moldings seek to provide some differentiation between identical units. Photo: B. Vint

Prominence of garage opening in finished street facade expresses primacy of the automobile. Photo: B. Vint

Placement of houses results in side yards which offer neither privacy nor sufficient outdoor space to serve any useful purpose. Photo: B. Vint

Civil engineering to accommodate rain runoff from streets and roofs leads to concrete-lined drainages as public spaces. These developments are technically adequate, but raise environmental and aesthetic issues. Photo: B. Vint

Overview of Arizpe, Sonora, with the cathedral tower prominently marking the town square, surrounded by numerous examples of courtyard housing.. Photo: B. Vint

The preceding summary illustrates both the gravity and uniqueness of border housing conditions. Yet throughout northern Mexico and the southwestern U.S. there are examples of successful traditional housing that provide a very satisfactory living environment. These examples are well worth studying to learn how and why they succeed, both in terms of their architectural design and the construction materials and methods employed

Northwestern Mexico and the Southwestern U.S. were once part of *La Nueva España*: New Spain. The legacy of Spanish culture in the region includes a tradition of town planning based on *La Recopilación de leyes de los reynos de las Indias* : the Laws of the Indies, which date to 1501. This document, issued by the Spanish Crown, was used by the conquering Spanish to establish their way of life in new lands. It contains 148 ordinances describing how towns and cities should be laid out.

The Laws of the Indies specify that a p*laza*, or central square, be created for each town or city. Surrounding the plaza are streets with homes brought to the street front, with private space contained inside at the *patio* or courtyard. This type of planning produced dense towns and neighborhoods without sacrificing privacy. The resulting urban form is compact, occupying less space in the landscape than today's suburban pattern of development.

To this day throughout Mexico and Latin America the plaza is an expression of civic pride, creating an island of tranquility in the heart of the city. With shade trees, benches, and a gazebo or *kiosko*, the plaza is an inviting and cool place to meet, for everyone from young couples to families with children and retirees. The plaza in the city plays a role similar to the *patio* , or courtyard, within the individual house. Architects and planners north of the border would do well to note the beauty of Mexican plazas, and look for opportunities to create common spaces where all are welcome.

The nature and character of a community is derived not only from the quality of its housing, but from its urban form. The layout of neighborhoods determines greatly the type of housing possible, and the type of lives people may lead there. Is the neighborhood walkable? Is there a sense of both community and privacy? Are there safe, well-watched places for kids to play? Is there adequate shade and fresh air? What is the environmental quality of life?

THE IMPORTANCE OF TOWN PLANNING

Ures. Sonora: The plaza is bordered by the city hall (Palacio de Gobierno) and the church of San Miguel Arcángel
Photo: B. Vint

THE RIO SONORA VALLEY

A particularly rich vein of traditional architecture is found along the banks of the *Rio Sonora* (Sonora River), which runs south of the border from Douglas, Arizona and Agua Prieta, Sonora. In the 17th century Jesuit missionaries explored this fertile river valley, founding towns and missions. Today there remains an intact chain of towns named Ures, Baviácora, Huépac, Aconchi, Banámichi and Arizpe – places with indigenous names, but endowed with the cultural legacy of Spain: urban architecture.

The town of Aconchi, Sonora, was founded in 1639. Houses are distributed around a central plaza fronting a colonial-era church, beside which is a carpentry shop named appropriately enough *Carpintería San José* (St. Joseph's Carpentry Shop). Aconchi is well known in Sonora for the production of wood furniture. Centuries after its founding, the traditional urban architecture of this Spanish colonial town continues to function as a livable environment for its inhabitants.

ACONCHI, SONORA

Plaza de Aconchi, Sonora Photo: B. Vint

Aconchi's houses are built of adobe brick finished with lime plaster. The houses are placed close to the street with private patios within. Since the houses are grouped closely together, Aconchi is a compact, walkable town, with a comfortably-scaled streetscape. This approach to housing uses land efficiently, for there are no side yards to fill up with broken washing machines or old bicycles, and no front yards with lawns to water or weeds to pull. To apply these ideas in the design of new affordable housing, some contemporary realities must be addressed, foremost among these the automobile. Cars can be brought in through narrow alleys behind the houses to maintain a pedestrian connection to the street. This creates a lively street presence and improved defensible space, in contrast to the streets of U.S. subdivisions, dominated by garage doors and a lack of individuality.

The view over the roof tops of Aconchi as seen from the bell tower of the church reveals the key to this type of urban architecture: the continuous street front is maintained by joined houses, behind which are private patios or courtyards. The houses have an "L" shape in plan to create the courtyard space, while sharing walls with their neighbors on each side. Shared walls reduce both initial construction costs and life-cycle energy costs, by reducing the amount of exterior wall required and exposed to the elements. This type of row housing yields a higher density than the detached single-family house typical of U.S. subdivisions.

Aconchi, Sonora: the importance of shade in the arid environment. Photo: B. Vint

Aconchi, Sonora: street scene adjacent to plaza. Photo: B. Vint

Aconchi Sonora: view over the rooftops of courtyard houses as viewed from the east tower of church. Photo: B. Vint

ARIZPE, SONORA

Arizpe is another gem of Spanish Colonial urbanism, a town of 15,000 which in the 17th century was the capital city of the entire region including Sonora, Arizona, Chihuahua and New Mexico. In the floor of the cathedral, a Jesuit structure from the first half of the 18th century, is the burial crypt of Juan Bautista de Anza, the Spanish explorer who founded San Francisco, California. Arizpe has all the elements of successful urbanism: walkable streets, public spaces, private courtyards, human scale, and an accessible rural hinterland. To the present day Arizpe exists as an agricultural town surrounded by pastures and fields. The valley is well irrigated by the Rio Sonora. Wheat fields and fruit orchards abound, and beef cattle are raised for export to the state capital, Hermosillo. Those families who own a house or plot of land in Arizpe are able to earn a decent living from the land. However, the limitation is that only a certain number can live directly off the land, and as the population grows, many young people find it necessary to move to the border cities of Nogales or Agua Prieta, or to Hermosillo to earn their livelihood.

Arizpe, Sonora: compact town form preserves surrounding landscape. Photo: B. Vint

Nonetheless, Arizpe holds important lessons for the architect and planner. The compact form of the town results from the predominance of courtyard housing, which permits higher density while maintaining privacy within each dwelling. A town with a comparable population built on the suburban model common north of the border would occupy four times the geographic area: the sprawling effect of suburbia is geometric.

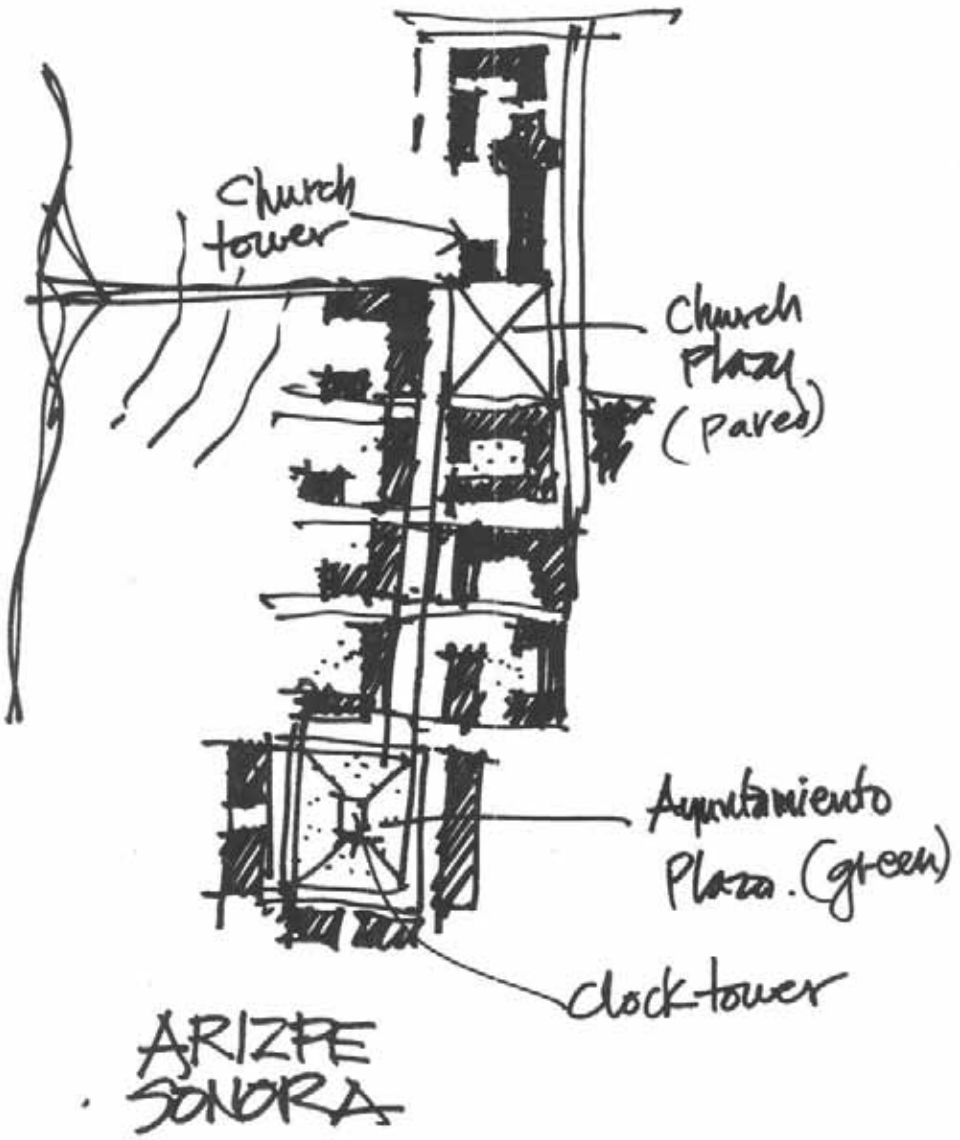
The greater efficiency of land use in Arizpe means that more arable land is left available for cultivation. This is a critical factor world-wide, as increasing urbanization consumes millions of acres of farm land, even as the population's need for food, clean water and fresh air increases.

The house forms of Arizpe are "L" and "U" shaped courtyard plans. These types of houses can be traced to ancient Greece and Rome. They are simple rectangular forms composed of rooms gathered around a central patio. They can be placed together side by side, or back to back, without compromising light, air and privacy for each house. Each individual dwelling obtains these vital elements from the patio, rather than from the perimeter. The urban form of Arizpe results directly from the courtyard house, and the types of housing blocks that can be assembled from it. The courtyard house achieves affordability by sharing walls between dwelling units: one can build a wall once, yet use it twice.

As is the case throughout the Rio Sonora valley, the houses are built of adobe. Roofs are framed with wood beams (*vigas*) and lathing (*latillas*) contained within parapet walls. This system of roofing, called *enterrado* in Spanish, is also found in Andalucía and North Africa, where it is known by its Arabic name, *alfarje*. The original roofing material in the historic period was earth: layers of adobe mud, approaching 12 inches in thickness, were applied over the latillas. Earthen roofs, like adobe walls, had the advantage of high thermal mass. However, because they were so slightly sloped and made of mud, they leaked chronically in the heavy monsoon rains of the Sonoran summers.

The earth roofs were supplemented in the 20th century with more steeply pitched roofs framed with milled lumber and sheathed with corrugated galvanized iron, added above the original earth layer. This has proven to be effective at water proofing -- inexpensive, and reasonably durable -- but has the drawback of being an excellent conductor of heat.

Nevertheless corrugated metal has become the predominate roofing type along the Rio Sonora, for its practical advantages. There is an insulation benefit to the attic air space created between the original earthen roofs and the upper waterproof roof of these Sonoran dwellings. The inward slope of the roofs as illustrated is ideal for harvesting rain water to irrigate the patios.



Arizpe, Sonora: Sketch plan of town, B. Vint

ARIZPE, SONORA

L-shaped house with heavily vegetated courtyard at corner. Photo: B. Vint

Rural adobe house set into the hills above Arizpe. Photo: B. Vint

U-shaped house at center of photo is a classical Latin design. Each room opens to a central patio for privacy, fresh air and light. The courtyard is the heart of the house. Grouping of volumes creates private patios within each dwelling. Photo: B. Vint

Ures was the 19th century capital of Sonora. Today it is home to some 30,000 people. A lush central plaza with great shade trees provides a physical, as well as symbolic, center to the town. In a harsh desert environment, shade filled plazas function as oases for the townspeople. They create a sense of place and well-being, and are expressions of civic pride.

While nearly every Mexican town and city is graced by a plaza, and many of the same elements are employed – a mix of paving, planting, benches, shade trees and a band stand -- no two plazas are alike. Ures has a particularly successful plaza, with two permanent refreshment stands selling *raspados de nieve* and *cimarrones,* locally made ices with fruit toppings and part of the traditional strategy for desert survival. The plaza functions much like a community living room, a place for people to gather and socialize, and creating a very human element in the urban landscape.

Adobe brick making was introduced to the Rio Sonora by the Spanish over three hundred years ago. To the present day, adobe construction remains widely practiced. Most of the buildings of Ures and other Rio Sonora towns are built of adobe. Houses are plastered with lime and sand to protect the mud bricks from weathering.

Street scene in Ures. Massive trees are evidence of central patio. Note un-plastered adobe garden wall to right. Photo: B. Vint

URES, SONORA

Ures. Sonora: Plaza within the city functions similarly to the patio within the individual home. Photo: B. Vint

Many of the houses surrounding the plaza of Ures are built on the principle of the zaguán: a central entry hall / breezeway that connects from the street to the patio at the interior of the house. In a traditional courtyard house, the zaguán is the transition from public to private, and also serves to permit the passive ventilation of the house. The zaguán is large enough to serve as a sitting room. As the street in front of the house is heated by the sun, air rises from it: meanwhile air in the patio is cooled by moisture from a concentration of plants or a fountain. As evaporatively cooled air sinks into the patio it is drawn through the zaguán by the heated air rising off the street. The zaguán, being open to adjoining rooms, draws fresh air into the interior of the house by means of natural convection.

From the street, the zaguán connects to the *corredor*, which crosses one end of the patio. The corredor is a covered outdoor space connecting the two sides of a courtyard house. Unlike the typical single-family American home placed in the center of a plot of land, the courtyard gathers the exterior space at the center of the house, where it is made private by the placement of rooms along the sides. This is a fundamentally different conception of the house, an expression of Spanish or Latin culture, and well-suited to the desert environment of the U.S./Mexico borderland.

Ures, Son View of zaguán (entry hall) from street.
Photo: B. Vint

Corredor and patio of house in Ures. The corredor provides a connection between the two sides of the house, and the patio captures a small piece of the exterior, transforming it with plants and shade into a cool micro climate.
Photo: B. Vint

The courtyard or patio house lends itself well to infill development of vacant land within an existing urban context, as houses can be built to property lines. The perimeter walls can be windowless or shared with adjacent dwellings for economy of construction as well as energy savings.

The patio serves to cool a house by natural ventilation and evaporative cooling. Cool air settles into the courtyard over night, cooling the floors and walls. During the day, heat rising from the patio creates convective currents, drawing air over plants or a fountain. Evapo-transpiration from plant leaves or a fountain lowers the sensible temperature of the air. The degree of cooling varies with many factors including relative humidity, elevation above sea level, the types of plants that will grow at a given location, and the degree of shading. While a quantitative analysis of this process is beyond the scope of this study, the prevalence of the courtyard house throughout hot-arid regions the world over testifies to its importance as a design strategy for desert dwelling (ref. Fuller Moore, *Environmental Control Systems*, p. 51).

Evaporative cooling is effective in hot-arid zones where relative humidity is low. Sensible heat is reduced by evaporating water into the air as latent heat. The total heat content of the air is unchanged. This system works where RH is consistently below 15%, which describes large areas of Arizona, New Mexico and Texas. Evaporative cooling uses significantly less energy than conventional air conditioning. The courtyard is thus both environmentally and culturally relevant to affordable housing in the Southwest.

Ures, Sonora, The plant-filled patio in a traditional house cools by evaporation. Photo: B. Vint

HUEPAC, SONORA

Huépac, Sonora Photo: B. Vint

Huepac street scene. Note the deep window recesses and shaded sidewalk resulting from placement of buildings close to the street. Photo: B. Vint

Another intact colonial town in the Rio Sonora valley is Huépac. Here can be appreciated the effect of the street-wall created by the juxtaposition of adobe row houses. Also visible is the shading effect of thick earthen walls, with windows deeply recessed: direct sunlight is kept from striking the glass by the depth of the window openings.

An added benefit of the narrow streets with buildings located close to the sidewalks is that one side or the other of each street will always be shaded by the building mass. Thus pedestrians can walk in the shade of buildings, protected from the withering desert sun. This makes walking bearable even on the hottest days, something which is impossible in typical U.S. suburbs with their detached houses.

Traditional houses in Huépac are of adobe, although recent constructions have been built of standard 8 inch thick concrete block. Block houses, although durable, do not function well because concrete conducts heat quickly through the walls. Adobe structures have the advantage of thermal lag, as heat travels slowly through earthen walls. Adobe, as documented in Chapter 3 of this report, is not a good insulator: it is a good thermal mass.

The streetscapes of Huepac and other Rio Sonora towns provide excellent models for the development of future affordable housing communities in the U.S. Southwest.