Traditional Influence on the Contemporary Single-Family Courtyard House

Serene S Kanaan
**Project Topic:**
Contemporary single-family courtyard house.

**Elevator Statement:**
Reintroducing the courtyard concept in contemporary housing typology that addresses energy and human comfort in the surrounding environment.

**Case Statement:**
In older traditional Middle Eastern residences, the courtyard was the focal point of the house. It is an architectural form of major importance in traditional houses in hot, dry climates. Most, if not all, rooms of the house had a direct connection with the courtyard. Courtyards served privacy purposes where they decreased interior-exterior connections but increased interior-interior connections; they maximized interior relationships and openness while keeping the outside separate. They helped create an interior garden while respecting privacy values of the culture by having no exterior or street view from the courtyard itself. Not only were courtyards used as social family gathering spaces, they were also a source of air flow and thermal comfort to the residence. A fountain was usually located in the center of the courtyard as an artistic element as well as to control climate. Courtyards are convenient outdoor spaces that positively affect microclimate and indoor thermal conditions.

By studying older/traditional Middle Eastern courtyard houses and the advantages the courtyard brought to the living quality of the house, this project proposes a contemporary design that uses the benefits of the courtyard while catering for today’s families. It also incorporates other traditional elements such as the screen to provide a breeze while obstructing the visual connection, and the wind tower which circulates the air and increases human comfort in the hot summer days. By reintroducing these elements through a study of dwellers' needs and their locale, the project will bring back the relationship between nature, architecture and inhabitant comfort, as well as create a strong relationship between inside and out.
Goal Statements and Guiding Principles:

Contemporary living in a redefined traditional Middle Eastern courtyard dwelling.
Traditional courtyard integrated within the contemporary house with appropriate local materials to provide a strong and viable courtyard home model.

Human comfort due to the courtyard.
Energy use, human comfort and affordability catering for today’s family needs.
Design tactics that address family ties and privacy through the balancing of collective family needs with individual privacy needs.

Promote natural systems and energy efficiency.
Decrease reliability on energy consuming mechanical systems and using the courtyard to provide seasonal and temporal comfort.

Design Response:

Reinterpret the exterior courtyard and integrate it with the house.
Modify special adjacencies for maximum use of courtyard.
Provide privacy and comfort through air, light and security.
Maximize air quality and inhabitant comfort through the use of the courtyard and its components.
Use modern building techniques with traditional residential elements to create an affordable, energy efficient and durable home.
**Courtyard:** an enclosed court that is open to the sky. Thermal performance of a courtyard deals with heat exchange between the courtyard, the indoors and the outdoors.

- Central indoor living space with exterior open space on two or more sides.
- Courtyard cutting through house creating two strips of indoor living space with a central outdoor courtyard space.
- Courtyard surrounded on three sides by interior living spaces.
- Courtyard surrounded on all sides by interior living spaces.
Phase 1
Cool night air descends into courtyard and fills surrounding rooms, walls, floors, roofs and ceiling which become cooled and remain so until the late afternoon. Once the sun is up, the courtyard loses heat by radiating it to the sky.

Phase 2
Once the sun strikes the courtyard directly around noon, the cool air starts to rise and leak out of rooms through convection. With the outdoor temperature rising, wall thickness and material prevent heat to penetrate through walls.

Phase 3
In the late afternoon, the courtyard floor and the interior of the house become warmer allowing for convection and heat exchange with the cool interior air.
Using natural elements to create shadow in an open courtyard.

Orientation in regards to sun and wind.

Ventilation through courtyard and the filtration of heat and sun through the use of vegetation.

thermal comfort/ Courtyard
Ancient Greece
Morocco
Colonial Latin America (Venezuela)
Ancient Egypt
Hispanic
Iraq
Syria
Plan of Chicago townhouses
Architect: Y.C. Wong, 1961
Fez, Tunisia
Courtyards and countries/ Courtyard
Courtyard

- Built area on site
- Courtyard

- House
- Buffer
- Wall
- Street

- Wall + House (no buffer)
- Street

- Setbacks
- House
- Setbacks
- Streets

- Wall + House
- Street
A courtyard is a horizontal aperture in which nature enters.
wind catcher / Malqaf
A shaft rising high above the building with uni or multi-directional openings facing the prevailing winds. It captures the wind from the top where it is cooler and stronger and channels it down into the interior of the building forcing it out through the openings. The malqaf can also acts as a chimney where it sucks out the warm rising air out of the building and creates thermal comfort due to the air circulation and replacement.
Hot heavy air is cooled as it goes down the wind tower, cools the space, then raises at it gains heat and exits through the window.

Cool air enters through the window, cools the space then raises up the tower as it gains heat from the space.

Positive pressure and lower temperature are created at the wind side and negative pressure and higher temperature from the sun are created at the opposite side. Venturi effect allows ventilation of the space through the wind tower.

Cool, fast moving air enters the tower, cools the space and is exhausted back up through the tower by the venturi effect.
A mashrabiya controls the passage of light, controls the air flow, reduces the temperature of the air current and ensures privacy.

Section/ the screen blocks the direct sun beams but allows for light to enter through the openings.

Section/ the opening allows for air to flow: cooler outside air enters as the heated interior air exits.

Section/ the screen creates privacy from the exterior, yet allows for an interior-exterior visual connection.

Plan/ the screen is placed at a projecting oriel window to catch air flowing from three sides and parallel draughts.
Thermal mass
thermal mass wall absorption of heat during the day

release of heat by thermal mass wall at night

overhang to control direct sun exposure of summer sun angle

heat absorbed by thermal mass slab exposed to winter sun angle during the day

heat release of thermal mass to the space during the night
Thermal mass effects on building envelope

- Moderate indoor temperature swing
- Reduced consumption

Outdoor temperature
Indoor temperature

Effects on temperature: Thermal mass

- Heavy building with external insulation
- Light timber-framed building

Time of day

Outdoor temperature

Illinois Institute of Technology Spring 2011 Arch593
Materiality
stone - concrete - stucco / Materiality
4'-10' surrounding wall/Boundary
Temperature

Recorded High
Design High
Average High
Mean
Average Low
Design Low
Recorded Low
Comfort Zone

Monthly Diurnal Averages

Temperature C
Dry Bulb Mean
Mean Bulb Mean
Dry Bulb (hourly)
Comfort Zone

Radiation (Wh/sq.m/hr)
Global Horiz
Direct Normal
Diffuse
<table>
<thead>
<tr>
<th>Space</th>
<th>Dimensions (m)</th>
<th>Quantity</th>
<th>Number of Occupants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bathroom</td>
<td>2 x 3</td>
<td>2.5</td>
<td>1-2</td>
</tr>
<tr>
<td>Bedroom</td>
<td>4 x 4</td>
<td>2.5</td>
<td>1-2</td>
</tr>
<tr>
<td>Dining</td>
<td>3 x 5</td>
<td>1</td>
<td>up to 16</td>
</tr>
<tr>
<td>Entry hall</td>
<td>2 x 3</td>
<td>1</td>
<td>N/A</td>
</tr>
<tr>
<td>Family living</td>
<td>6 x 6</td>
<td>1.2</td>
<td>up to 8</td>
</tr>
<tr>
<td>Formal living</td>
<td>8 x 8</td>
<td>1.2</td>
<td>up to 25</td>
</tr>
<tr>
<td>Garage</td>
<td>5 x 7</td>
<td>1.2</td>
<td>2 cars</td>
</tr>
<tr>
<td>Guest washroom</td>
<td>1.5 x 2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Kitchen</td>
<td>5 x 6</td>
<td>1</td>
<td>2-3</td>
</tr>
<tr>
<td>Laundry</td>
<td>3 x 3</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

* Average typical middle-class area requirements of a residence
Connection to courtyard

Direct
- Dining Room
- Formal Living
- Family Living
- Kitchen
- Bedrooms

Possible
- Entry Hall
- Laundry
- Storage
- Garage

No
- Bathrooms
- Storage
- Garage

Program: space zoning
Illinois Institute of Technology     Spring 2011     Arch593

private vs. public

visual catalog of spaces

Program
functions as groups / Program
urban site

category: residential B
minimum lot area of 8750 ft²
setbacks:
front: 13'
side: 13'
back: 20'
lot dimensions:
118' x 82'
lot area: 9690 ft²

suburban site

category: residential C
minimum lot area of 5380 ft²
setbacks:
front: 10'
side: 10'
back: 13'
lot dimensions:
118' x 61'
lot area: 7170 ft²

building codes and restrictions/Sites
urban neighborhood: massing + boundary walls

Sites
Illinois Institute of Technology     Spring 2011     Arch593

Urban site concept: layering/

W-facing street + winds
S-facing neighbor
E-facing neighbor
N-facing neighbor + winds
Urban site initial program planning
**AUGUST 15**
- Dry-bulb temperature: Jordan
- Air temperature in basic
- Air temperature with shading + thermal mass
- Air temperature with wind tower
- Air temperature with courtyard
- Air temperature with trees
- Air temperature of final design
JANUARY 15

- Dry-bulb temperature: Jordan
- Air temperature in basic
- Air temperature with shading + thermal mass
- Air temperature with wind tower
- Air temperature with courtyard
- Air temperature with trees
- Air temperature of final design
Almond tree- ornamental
Flowers in early spring
Leafy year round
Grows up to 15-30 ft high

Lemon tree- fruit + shade
Flowers from summer to autumn
Evergreen
Grows up to 40 ft high

Olive tree- fruit + shade
Olives harvested in early winter
Evergreen
Grows up to 25-50 ft high

Weeping willow tree- shade
Flowers from early spring
Seasonal change of color
Grows up to 65-80 ft high

Cypress tree- shade + wall
Evergreen
Grows up to 100 ft high
Illinois Institute of Technology     Spring 2011     Arch593

Urban site

public-private spaces
Urban sitescreen walls
10' 20' 30'

screen walls / Urban site
Urban siteviews: in, out, through
Urban site
interior vs. exterior
proposed typology - ground floor / Urban site

Illinois Institute of Technology  Spring 2011  Arch593
courtyard sun exposure during the day

courtyard at night
view through entrance

family living space transparency
street side

concept layering / Suburban site
initial program planning/Suburban site
Suburban site energy analysis: hottest temperature:

- Dry-bulb temperature: Jordan
- Air temperature in basic
- Air temperature with shading
- Air temperature with wind tower
- Air temperature with courtyard
- Air temperature with trees
- Air temperature of final design

AUGUST 15
energy analysis: coldest temperature/

Suburban site

JANUARY 15

- Dry-bulb temperature: Jordan
- Air temperature in basic
- Air temperature with shading
- Air temperature with wind tower
- Air temperature with courtyard
- Air temperature with trees
- Air temperature of final design
Suburban site energy analysis: wind/

Integrated Environmental Solutions, Virtual Environment Analysis

SUMMER 06:00 12:00 18:00

Volume Flow (cfm)

- External ventilation in basic
- External ventilation with shading
- External ventilation with wind tower
- External ventilation with courtyard
- External ventilation with trees
- External ventilation of final design
Suburban site

vegetation wall layering
public-private spaces/Suburban site
Suburban site screen walls

Illinois Institute of Technology
Spring 2011
Arch593
views: in, out, through / Suburban site
Suburban site
interior vs exterior
Suburban site

courtyard spaces
Suburban site

interior-courtyard overlaps
proposed typology - ground floor / Suburban site
suburban proposal section showing air flow

prevailing wind

cooled by shading

warm air enters space

cooled by shading

prevailing wind/
warm air enters tower and courtyard

warm air drawn out
view of the courtyard at noon

screen transparency
view through entrance

family living space transparency into courtyard
Halawa House. Agamy, Egypt 1975
Abdelwahed El-Wakil

The architect has drawn upon traditional Islamic or Egyptian prototypes for the design of this house. In addition to the courtyard and its fountain, the house has a loggia, a wind catch, alcoves, masonry benches and a belvedere. The house works very well in Egypt’s hot climate. The walls and roof are designed to provide insulation, sunlight filters through mashrabiyyas, and the courtyard draws fresh sea air down through the wind catch.
Sims and Sednaoui Residence. Luxor, Egypt 1980
Sims and Sednaoui Architects inspired by Hassan Fathi

An indigenous courtyard house with a square base located on the west bank of the Nile River across the city of Luxor in Egypt. The large, private house is designed for the part-time use of the architect-clients and embodies the architectural concepts upon which they hope to develop their practice. The making of the residence was an experiment in building. By investigating a mode of rural construction traditional to Egypt, the architects intended to become familiar with existing conventions in mud brick technology. Using Hassan Fathy’s work as a point of departure, they intended to explore the technology’s potential with the intention of applying their experience to subsequent projects.
This house has a central courtyard, which faces north for winter sunshine, and gives great privacy to the occupants. Every room faces onto the courtyard and thus gets good light and ventilation. The house is exceptionally well insulated and has very high thermal mass with concrete floors on both levels and all internal walls in Hebel block to maximise passive heating. The house provides both high environmental performance and good internal amenity and privacy on very small land areas.
Irshad Mecca House. Amman, Jordan. 2006
Ayman Karazoun Architects
5 bedrooms, 7825 sq.ft.

A house centered around a courtyard with water features as its focal point. A gallery space, Iwan, separates the main entrance from the courtyard for privacy reasons. Also, an exterior formal garden creates a continuity between both green spaces. Sleeping quarters are located on the upper floor and they all overlook the courtyard.
The Horn House. Los Angeles, California. 2007
Tom Robertson of Ripple Design
3 bedrooms, 2,800 sq.ft.
A green sustainable design featuring dramatic indoor-outdoor living spaces with a huge courtyard.
Idyllic Interior Courtyard. Seal Rocks, Australia 2009
Blue Bourne Architects

This coastal cottage home was designed around an inner garden and deck – ideal for outdoor entertaining – and is bordered by glass walls that flood the house with natural light while minimizing exterior glazing, for privacy. Sliding glass doors allow for indoor-outdoor living – a must in this idyllic warm-weather environment. This vacation house is finished with minimalist interiors – simple materials that fit in with the context of this fishing village. The cottage’s rustic style comes via CFC-clad walls, polished particleboard floors and locally sourced wood for the decks.
San Pablo Residence. San Juan, Puerto Rico. 2009
URBANA Architects.

Client’s request: “...a structure that would evoke the clarity of mid-century Puertorrikan modernism, with the charm and climatic responsiveness of their courtyard, Moorish-styled, Old San Juan loft.”

“The project became one of reconsidering the ‘Spanish courtyard house’ typology, itself an offspring of the Islamic influence on southern Spanish architecture, and an emblematic model of some of the early, native urbanización [development] projects in Puerto Rico.
F White House. Kishawa, Japan. 2009
Takuro Yamamoto
1 bedroom, 131.5 sq.ft.

This one storey house is centered around a rectangular courtyard that has been rotated at an oblique angle which becomes the center point that divides the interior to smaller space.
L: The house of an Afghani family in Peshawar, North-West Pakistan. The living quarters are surrounded by a thick, high wall and are entered through a single door seen on the left of the picture.

R: Akil Sami Residence in Dahshur, Egypt by Architect Hassan Fathi. This image shows minimum openings towards the street.
L: Imam Square inner courtyard, in Esfahan, Iran showing water feature at the center of the courtyard.
R: The communal courtyard of the Umayyad Mosque in Damascus, Syria showing a central courtyard with ‘iwan’ on all sides.
L: Interior courtyard of the Talisman Hotel in Damascus, Syria. Once an old palace built in a quiet side street has now been restored in the most authentic tradition of an Arab house.

R: Residence Andalous in Sousse, Tunisia by Architect Serge Santelli. The architect tried to achieve a contemporary expression of the structural principles that govern traditional Arabo-Islamic architecture. The regularity and simplicity of interior courtyards surrounded by porticoes similar to those in Tunisian fondouks; gardens treated architecturally; iwans, pools, fountains, and pergolas are the elements which were an essential part of the spatial design of the whole.
References

1 housedesignnews.com, 2 exinteriordesign.com, 3 archdaily.com, 4 modern-homes.net, 5 archdaily.com, 6 juvansign.com, 7 bp.blogspot.com, 8 exinteriordesign.com, 9 greatfi.com, 10 archinspire.com

Ragette, Friedrich; Reynolds, John
http://www.akdn.org/architecture
http://www.archnet.org
http://www.architecture01.com
http://www.thehornhouse.com
http://www.trendir.com
http://www.urbana-arquitectura.com
http://www.3.ocn.ne.jp

Precedents + Case studies through the process

see references

Dwell Magazine. July 2010

Pearlmutter, Erell, Etzion, Mier, Di; Refining the use of evaporation in an experimental down-draft cool tower. The Center for Desert Architecture and Urban Planning, Israel.

Bibliography

Books

Edwards, Brian; Magda Sibley; Mohammad Hakmi; Peter Land. Courtyard Housing: Past, Present and Future. 2005
Pfeifer, Gunter. Courtyard Houses, A Housing Typology. 2003
Rabbat, Nasser O. The Courtyard House. 2010
Ragette, Friedrich. Traditional Domestic Architecture of the Arab Region. 2003
Steele, James. The Architecture of Rosam Badran. 2005

Websites

see references

Magazines + Journals

Dwell Magazine. July 2010