Armadillo Residence

JOHN E. FOLAN
Carnegie Mellon University

DRACHMAN DESIGN BUILD COALITION (DDBC)
University of Arizona

Figure 1: View of ARMADILLO RESIDENCE from the Northwest

The ARMADILLO RESIDENCE *(Figure 1)* is 1,198 SF sustainable affordable housing prototype developed for families with an annual income level falling below the eighty percent median household income level in the Tucson, Arizona metropolitan region. It is the third prototype developed by the Drachman Design Build Coalition (DDBC), a non-profit 501c3 corporation affiliated with the University of Arizona College of Architecture and Landscape Architecture. The DDBC offers faculty and student technical expertise to the local community in Southern Arizona with the expressed mission of developing and disseminating regionally specific, energy efficient design strategies to a broad audience. The ARMADILLO RESIDENCE was designed by Associate Professor John Folan and constructed under his and Professor Mary Hardin's supervision with University of Arizona students. The design work was completed as part of the Civano Demonstration Project Grant, a two hundred and thirty-four thousand dollar grant awarded to the DDBC by the City of Tucson. Development and construction was funded through a line of credit provided by the Industrial Development Authority of Tucson.

Site

The house is sited in the Barrio San Antonio Neighborhood on a 0.71-acre parcel of land located just west of Tucson's Central Business District. A regional transportation artery forms the southern boundary of the site. The City of Tucson Community Services Agency deeded the parcel to the DDBC in March of 2007. Following the transaction, the DDBC initiated a year long rezoning and subdivision process that resulted in site reclassification from industrial to residential use. As a condition of the rezoning the vacant parcel was subdivided into five lots matching common infill lot sizes in Tucson's Empowerment Zone.

The ARMADILLO RESIDENCE occupies one of the 50' wide by 125' long lots. Development and construction of the house occurred simultaneously with DDBC RESIDENCE TWO on an adjacent lot in an effort to test masterplan and landscape strategies. All lots on the parcel are united by a masterplan that

has incorporated strategies to maintain water on site through the use of xeriscape microbasins and 100% rainwater collection from roofs and hardscape features in, and surrounding, the site *(Figure 2).* The remaining three lots will sustain development of forthcoming affordable housing projects under the umbrella of this and other research grants.

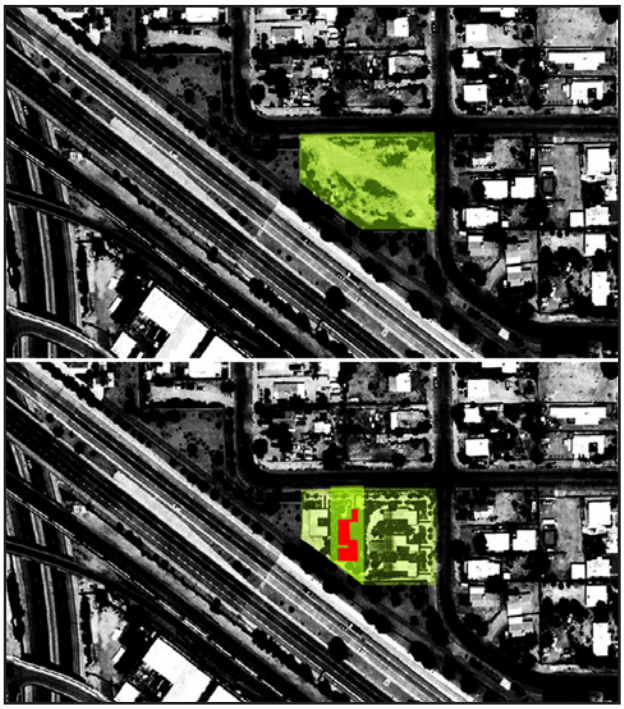

Figure 2: Top- 0.71-acre site deeded to the DDBC by the City of Tucson Community Services Agency. Barrio San Antonio Neighborhood context to East and North, Aviation Highway to South and West. Bottom – Site as subdivided for five typical infill lots with microbasins and xeriscape zones identified; ARMADILLO RESIDENCE sited on 50' wide by 125' long lot with predominant North-South axis.

Form/Organization

Conceptually, the organization and form of the ARMADILLO HOUSE are generative responses to the severe environmental conditions of the Sonoran Desert. Oriented with a predominant north/south axis, a strategy has been developed to manage the intense solar conditions on the eastern and western exposures. A pair of shaded courtyards are established, one on east side of the house and another on the west that enable the dwelling to wrap around and shade itself from the sun. The courts are positioned relative to one another and the enclosed building mass in a manner that induces positive airflow for maximum passive ventilation. The prevailing winds from the southeast and southwest are channeled from the south façade of the residence through the primary circulation corridor *(Figure 3)*.

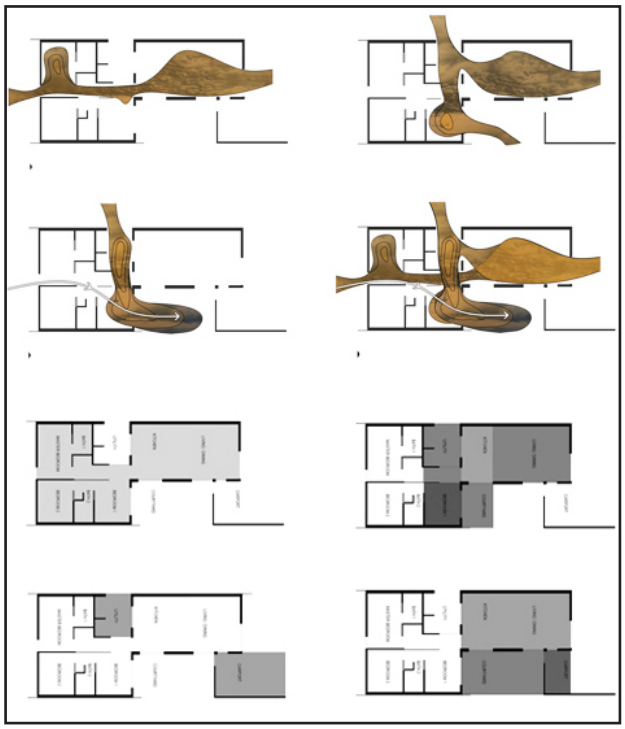

Figure 3: Top-Diagrams indicating the confluence of different lateral passive ventilation strategies enable by the offset courtyard plan; Bottom – Spatial Diagrams illustrating how the operable walls and flex spaces enable the residents to expand communal space, reconfigure the spatial organization, and blur the boundary between internal and external spatial zones.

Ventilation apertures off of the courtyards introduce cool air into the corridor which propels the mixed air through the primary living area and out of a small aperture located near the top of the north façade. A twelve-foot long operable panel located in the primary passive ventilation corridor enables the development of spatial continuity between independently identifiable zones that traditionally remain static/segregated in affordable housing prototypes. The flexibility provided by the moving partition and offset courtyards enable multi-generational families to configure the house in a manner that best suits their working and living behavior. It further reinforces the ability to engage larger por-

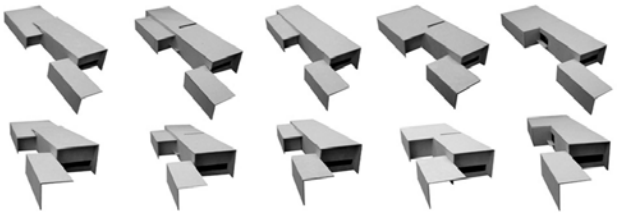

Figure 4: Iterative study models utilized to study the sympathetic configuration of the protective channel/shell and courtyards.

Figure 5: View of ARMADILLO RESIDENCE from the southwest looking northeast past Cistern 3 and the shaded exterior court.

Figure 6: View of ARMADILLO RESIDENCE from the southeast looking northwest past the primary east court, Cistern 2 and the carport.

tions of habitable area that extend to the urban context – retracing vernacular traditions.

The formal strategies employed in the house facilitate the fluid behavior through the creation of a sloping insulative shell, or channel, that protects the harshest exposures on the site – the east, south, west, and roof exposures. Apertures are eliminated on the east and west exposures unless the mass of the building provides appropriate shading. The slope of the roof and expansion of the spatial geometry from south to north enhances passive air flow and draw from the cooled air in the flanking courts *(Figures 4, 5, and 6).*

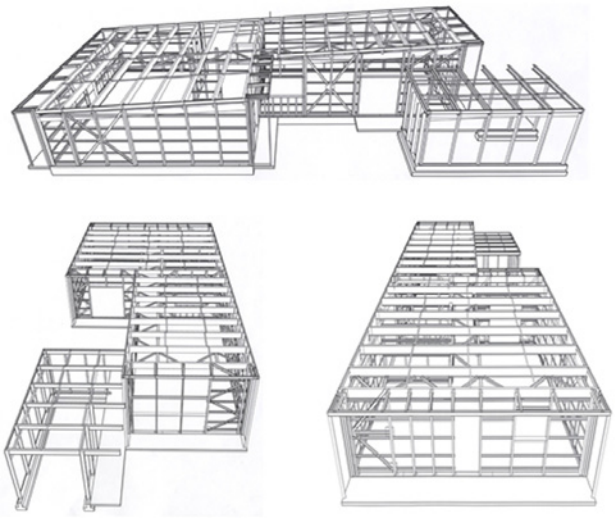

Figure 7: Structural BIM Model developed by John Folan with University of Arizona students Grant Noonan, Steve Olson, and Ryan Lyng illustrating the structural framing strategies employed.

Material and Structure: The insulative shell is constructed of light gauge steel framing and profile metal panel. It is expressed on the eastern, western, and roof exposures only. On the northern and southern exposures, where air and light are being filtered, a ventilated fiber cement panel screen wall is employed to mitigate heat gain. The structural frame is constructed of light gauge steel members placed on 4'-0" centers. There are three lateral trusses integrated into the frame to resolve shear forces *(Figure 7).* This constructive strategy enables erection of the structural frame for approximately one third the cost of conventional light gauge framing; an economic parameter that is critical in the realization of the phenomenological and physical conditions proposed.

The structural, formal and material strategies employed in the realization of the project required the enclosure to be draped over the structure – providing absolutely no lateral support. This enabled the skin to be entirely isolated/liberated from the structure -maintaining a consistent, non-bridged, developed insulative value of R-42 throughout the entire enclosure system.

Hat channels utilized for the definition of interior space and finishes were also isolated from the frame through the use of one inch thick isolating blocks. The interior finish is draped on the structure in the same manner as the exterior enclosure. This enables the skin of the residence to clearly express what environmental condition is being mitigated or exploited – defining a clear systemic logic.

Social Aspiration/Evidence: As is the case with all DDBC projects, the ARMADILLO RESIDENCE/ RESIDENCE THREE has been permitted as a model and the drawings will be made available to other non-profit affordable housing providers once a three-year monitoring period and full post occupancy evaluation has been completed. The house was sold for $118,000 in 2009 to a qualifying family. The pro-forma developed for other non-profit housing providers indicates that they will be able to deliver the project to market at the same price based on current economic forecasting. Fundamental to the production of the prototype has been consistent critical analysis and constructability refinement. The use of BIM and sequential three-dimensional shop drawings have been critical in that enterprise – an enterprise focused on bringing regionally specific sustainable design to those less fortunate.

Figure 8: Top: view of primary courtyard looking northwest through the carport – shade structure and pass through to kitchen at left hand side of image; lower left: interior view looking east toward shaded court; lower middle: view of primary entrance from carport; lower right: exterior view from southwest looking northeast.