"The HVAC-centered form of comfort that has proliferated since the postwar era was only ever attainable by a privileged few."

– After Comfort: A User's Guide, Daniel A. Barber et al.

Climate I Material I Shelter

Leveraging Earth-Based Construction for Sustainable Community Development

Course Coordinators

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Context

Maricopa County is one of the fastest growing metropolitan regions in the United States. It is also an area facing the distinct prospect of becoming uninhabitable by the end of this century due to extreme heat. Summertime high temperatures will average three to five degrees hotter by 2050 and they are predicted to increase to more than nine degrees by 2100. Most of the city's 2,000 square miles of urban sprawl consists of buildings that are entirely unsuited for an extreme desert environment. Interestingly, many of these structures mimic the massive appearance of traditional adobe architecture once prevalent in the region, however only a thin layer of cement stucco disguises the modern-day materials of lightweight wood framing and insulation, a system that contributes to the region's dependency on imported resources and mechanical systems for heating and cooling year-round.

By contrast, massive earthen structures provide a buffer against outdoor temperature fluctuations; earth's capacity to absorb, store, and radiate heat tempers indoor ambient environments. Early inhabitants, such as the Ancestral Sonoran Desert People, and later Spanish missionaries, relied on these properties to shelter from the harsh climate of the Sonoran Desert. Today, however, only a handful of historic adobe structures still stand in the city, and earth might see only occasional use for constructing high-end, single-family residences that do not capitalize on the energy-saving properties of the material.

As populations and global temperatures increase, sustainable solutions for housing are becoming ever more critical. This is made even more urgent as international manufacturing and supply chains continue to be disrupted and fuel prices reach record levels. Rather than relying on new technologies or automation for solutions, this proposal argues for a return to simpler principles found in older forms of construction that prioritize minimally transported and processed materials. Climate responsive systems leveraging earth-based construction could pave the way for innovative, cost-effective, and place specific cooling solutions with the capacity to meet contemporary needs.

These methods become even more crucial when considering low-income households–particularly those belonging to people of color and the elderly–that face a disproportionate financial burden when it comes to cooling their homes.[1]

Residents living below the poverty line are more likely to live in poorly insulated homes without energy-efficient cooling systems, necessitating the need to spend a significant portion of their income on electricity bills or to resort to air conditioning rationing, a practice that can have fatal consequences.

Earth-based systems offer a wide range of benefits that have yet to be thoroughly explored within the context of the US construction market; this is attributable to a complex set of barriers that include building regulations, stigma related to the use of soil as a building material, the lack of familiarity within the ACE industry, and the need for skilled labor.

Course Description

The course will advance the University of Washington and Arizona State University's mission to leverage place, enable student success, and transform society through use-inspired research.

Students making compressed earth blocks in Scottsdale, AZ

This course is the first of a multi-year, fourth-year research studio that will explore how earth-based construction (compressed earth block) might be leveraged for sustainable urban development (housing) in the Phoenix metropolitan region. The design studio will bring together students and faculty from both programs at the University of Washington and Arizona State University through in-person visits and virtual meetings and reviews.

Each year the studio is offered will be organized according to scale – the scale of a wall, the scale of a family, and the scale of a community. Year one will include material testing; Year two will incorporate construction faculty and students; and in Year three students will work with Real Estate faculty and students to develop an economic model in parallel with an architectural proposal. Knowledge and data will be cumulative, with each studio learning and building from the previous year's investigations.

We will begin the quarter/semester studying existing conditions and precedents in the southwest. The second phase will include actual brick-making. The third will introduce interdisciplinary faculty and students.

Year One **Scale: wall**

Module 01. Learning from the Past (2 weeks)
Report on earthen construction in the Southwest
Site visit to Tucson to see Sonoran Rowhouses

Module 02. Building in the Present (2 weeks)
Brickmaking workshop
Brick testing
Prototype development and (window, door, corner, foundation, roof), thermal performance testing

Module 03. Living in the Future (6/8 weeks)
Develop wall prototypes
Develop working drawings in conjunction with sustainable engineering faculty and students
Exhibition of wall detail mockups

Working with our collaborators, students will develop energy and economic metrics, full-scale prototypes, alongside compelling graphic documentation that illustrate how the material, and its production and implementation, could transform the environmental and economic development of the Phoenix metropolitan area. In addition, the research will be disseminated in a number of formats—online, as a physical exhibition, academic papers, and media releases—with the goal of demonstrating the material's capacity and potential to the AEC industry, local leaders, and the general public, while also introducing the next generation of future architects to an important and significant resource that is deeply connected to the region's landscape, history, and people.

Resources and Capacities

The course coordinators, Professors Elizabeth Golden from the University of Washington and Marc Neveu from Arizona State University, are uniquely qualified to lead this studio investigation and material research. The studio investigation is informed by previous interdisciplinary work involving students from UW and ASU, the City of Scottsdale, and community leaders to design and realize a shelter for asylum seekers constructed with compressed earth block and located in Mesa Arizona. Additionally, Golden brings expertise from her work on Niamey 2000, a high performing, low-tech multifamily complex in Niger, which has been recognized

Multifamily housing constructed from local soil, Niamey, Niger

by the Aga Kahn Foundation for its climate responsive integration of locally sourced building materials (compressed earth block) for contemporary housing.

The studio will collaborate with Adobe in Action, a non-profit organization that supports earth-based construction through education, the Center for Real Estate Theory and Practice (ASU), and the School of Sustainable Engineering and the Built Environment (ASU).

We see enormous potential in municipalities manufacturing their own locally sourced, low carbon building materials for the purpose of constructing climate responsive housing. This research studio is an initial step toward wider adoption of earth-based systems in the Southwest, with the goal of developing multifamily prototypes that are affordable and accessible to low-income households.

Future Studio Structure / Work Plan

Year Two Scale: family
Module 01. Learning from the Past (2 weeks)
Report on suburban development in the Southwest
Site visit to Sun City, Beadle Neighborhoods

Module 02. Building in the Present (2 weeks)
Brickmaking workshop
Brick testing
Prototype development. thermal performance testing

Module 03. Living in the Future (6/8 weeks)
Develop unit prototypes
Develop working drawings in conjunction with construction management faculty and students
Exhibition of housing proposals

Year Three Scale: community
Module 01. Learning from the Past (2 weeks)
Report on development in the Southwest
Site visit to Arcosanti, Culdesac

Module 02. Building in the Present (2 weeks)
Brickmaking workshop
Brick testing
Prototype development, thermal performance testing

Module 03. Living in the Future (6/8 weeks)
Develop unit prototypes
Develop Real Estate Prospectus in conjunction with real estate faculty and students
Exhibition of communal living proposals

1. A. Jones, D. Nock, C. Samaras, Y. Xing, *Climate change impacts on future residential electricity consumption and energy burden: A case study in Phoenix, Arizona,* Energy Policy, Volume 183, 2023.

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Material
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Art of Earth Architecture, Jean Dethier
Building from Tradition: Local Materials and Methods in Contemporary Architecture, Elizabeth Golden
Building with Earth, Gernot Minke
Earth Architecture, Ronald Rael
PortaLab Manual: Low-Cost Soil-Engineering Test for Constructing Earthen Buildings, Howard Scoggins
Upscaling Earth: Material, Process, Catalyst, Anna Heringer, Lindsay Blair Howe, and Martin Rauch

Shelter
Cross-Cultural Vernacular Landscapes of Southern Arizona, Laura H. Hollengreen R. Brooks Jeffery
Indigenous Landscapes and Spanish Missions : New Perspectives from Archaeology and Ethnohistory
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Metropolitan Phoenix: Placemaking and Community Building in the Desert, Patricia Gober

Partners

Adobe in Action
Center for Real Estate and Practice (ASU)
Center for Negative Carbon Emissions (ASU)
Center for Smart Cities and Regions (ASU)
City of Phoenix
City of Tempe
Decision Center for a Desert City (ASU)
Metis Center for Infrastructure and Sustainable Engineering (ASU)
Stardust Center for Affordable Homes and the Family (ASU)
Sustainable Cities Center (ASU)
The Earthen Architecture Association
The Earth Building Research Forum