BUILDING HEALTH: *Resilient Building Materials for Global Health & Sustainability*

Course Proposal for the 2024 ACSA Brick in Architectural Education Prize

Course Description:
This course focuses on the design and development of brick prototypes, highlighting their transformative potential as catalysts for change at the intersection of the built environment, public health, and global development. Students will explore how bricks can be reimagined to improve thermal comfort within homes in low-resource, tropical settings, while simultaneously preventing the entry of disease-carrying insects. By focusing on conventional construction materials like bricks, the course challenges the reliance on high-tech solutions, offering a more accessible path toward resilient and healthy development. These brick prototypes become essential tools for shaping not just physical spaces, but also the cultural landscape, illustrating how thoughtful material choices can influence both housing design and public health outcomes.

Open to all students with an interest in sustainable design, construction, and global health, this class offers a unique opportunity to contribute to cutting-edge research that explores the role of traditional building materials in enhancing energy efficiency, comfort, and disease prevention in low-resource, tropical settings. Key learning outcomes include:

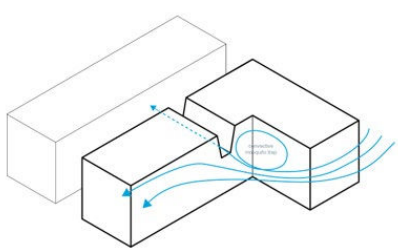
1. Gain environmental literacy in relation to brick production, land use, energy consumption, and material sustainability in both urban and rural environments
2. Understand the cultural, environmental, and health implications of using traditional brick materials in various contexts
3. Develop collaborative design and fabrication protocols for creating sustainable brick prototypes that contribute to ongoing research on resilient building materials
4. Apply principles of thermodynamics and material science to design innovative brick prototypes that enhance building performance in diverse climates

Background:
Long identified as a disease associated with poverty, over 90% of malaria cases and fatalities are concentrated in the world's poorest countries.[1] Despite clear linkages between malaria transmission and material precarity, contemporary malaria control has largely relied on two 'scalable' interventions: the spraying of residual chemicals on interior surfaces (indoor residual spraying, or IRS) and the distribution of long-lasting insecticide-treated bed nets (LLINs).[2] These frontline tools have been attenuated by insect resistance and mosquito behavioral change, while increasing temperatures and extreme rainfall patterns, have only extended the range and disease-carrying capacity of key disease vectors, amplifying global risk of infection.

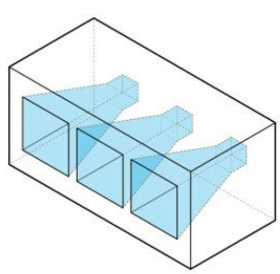
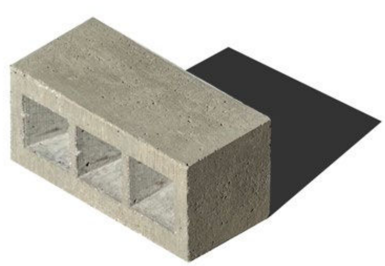
Though housing was once a key focus for mid-twentieth century government and post-world war development efforts, it has largely been neglected in the global health agenda, which instead prioritizes commodities, or market-based-solutions, that operate at scale and can be distributed uniformly across diverse populations and landscapes.[3] This course reexamines the humble brick as a material that can revolutionize housing in the context of global health, particularly in the area of malaria control. By reconsidering how homes are designed and built, this course aims to strengthen the link between healthy living and sustainable development, offering an innovative approach to addressing global health challenges through architectural solutions.

Subtle changes to the brick's geometry can enhance its ability to absorb, store, and release heat efficiently. By also leveraging the dynamic properties of air—to facilitate convective heat transfer, cool the body, and disrupt the flight of disease carrying insects—small modifications to the brick's design can contribute significantly to enhanced environmental and public health outcomes. **While the course focuses on one specific region, it aims to inspire students to explore the transformative potential of even the simplest building materials on a global scale.**

Early student prototypes include the "Vortex Block," (below, top) designed by Michael Serrano. This prototype employs principles of vortex shedding to enhance air movement around the brick. Vortex shedding occurs when air flows around a surface, creating alternating vortices or swirling flows. By strategically designing the brick to induce these vortices, small convective pockets are introduced to trap mosquitoes, disrupting their flight. At the same time, the design allows for turbulent air to flow to circulate, cooling the surrounding environment and reducing the accumulation of heat. The "Venturi Block," designed by Nathan Smith (below, bottom), uses the principles of the Venturi effect to create a cooling effect and disrupt mosquito flight. This block incorporates a truncated, horizontal hollow core, which decreases pressures and increases the velocity of air as it passes through. As air accelerates through the narrow core, the reduction in pressure creates a cooling effect while disturbing the flights of mosquitoes by altering airflow patterns in the vicinity of the brick, reducing their ability to navigate the space effectively.




"Vortex Block"
Michael Serrano, 2023

"Venturi Block"
Nathan Smith, 2021

Course Structure:
This course builds on earlier iterations offered exclusively as a design-studio format for architecture students. In this updated version, the course has been restructured as a 3-credit technology elective, cross-listed between architecture and civil engineering. By expanding the course to include students from both disciplines, it fosters interdisciplinary collaboration and bridges the gap between design and engineering, allowing participants to explore the technical, ecological, and health-related dimensions of sustainable brick construction.

Students will engage in interdisciplinary research, design, and fabrication, exploring bricks as a "disruptive technology," emphasizing how basic principles of physics and material science can transform accessible, traditional building materials into innovative solutions for housing and health. The tentative schedule is as follows:

> **Weeks 1-6: Prototyping**
> Students will design (at least) three different bricks prototypes out of poured materials such as plaster or ready-mix concrete, including a (1) Brick that *stores,* (2) Brick that *permeates,* and (3) Designer's choice. This assignment is intentionally open-ended to encourage creativity and exploration. The goal is to identify synergistic relationships between material properties, environmental challenges, and building performance that may not yet have been fully explored. This phase will allow for iterative experimentation, fostering and environment of innovation and interdisciplinary thinking.
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> **Weeks 7-12: Material selection, fabrication, and testing**
> Students will choose one prototype to develop and begin the transition from poured materials to real earthen materials such as clay, mud, or adobe. This phase will focus on the practical aspects of brickmaking, with an emphasis on understanding material composition and optimizing for structural integrity, sustainability, and thermal performance.
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> **Weeks 13-16: Final prototyping, performance evaluation, and presentation**
> In the final phase of the course, students will concentrate on "perfecting" their prototypes and preparing for the final presentation and evaluation of their work.

Statement of existing funding and partnerships:
This course is part of a 3-year, NSF-funded research project*, Sustainable Housing & Protective Building Materials: Masonry as a Link Between Accessible Construction, Energy, Human Comfort, and Mosquito Control in Rural Tanzania.* While NSF funding supports student and faculty travel, it does not cover brick prototype development. The ACSA Brick Education Prize will provide crucial resources for creating and testing these prototypes in collaboration with researchers at the University of Dar es Salaam and the Ifakara Health Institute. This additional funding will directly enhance students' hands-on learning, support materials procurement, and help position students for future research opportunities. These existing partnerships and funding establish a strong foundation, but the prize funds would be instrumental in achieving the project's full educational and research potential.

References:

1. Bofu, Ramadhani M., Ellen M. Santos, Betwel J. Msugupakulya, Najat F. Kahamba, Joseph D. Swilla, Rukiyah Njalambaha, Ann H. Kelly, et al. 2023. "The Needs and Opportunities for Housing Improvement for Malaria Control in Southern Tanzania." *Malaria Journal* 22 (1): 69. https://doi.org/10.1186/s12936-023-04499-1.
2. Kelly, Ann H, and Uli Beisel. 2011. "Neglected Malarias: The Frontlines and Back Alleys of Global Health." *BioSocieties* 6 (1): 71–87. https://doi.org/10.1057/biosoc.2010.42.
3. Cousins, Thomas, Michelle Pentecost, Alexandra Alvergne, Clare Chandler, Simukai Chigudu, Clare Herrick, Ann Kelly, et al. 2021. "The Changing Climates of Global Health." *BMJ Global Health* 6 (3): e005442.