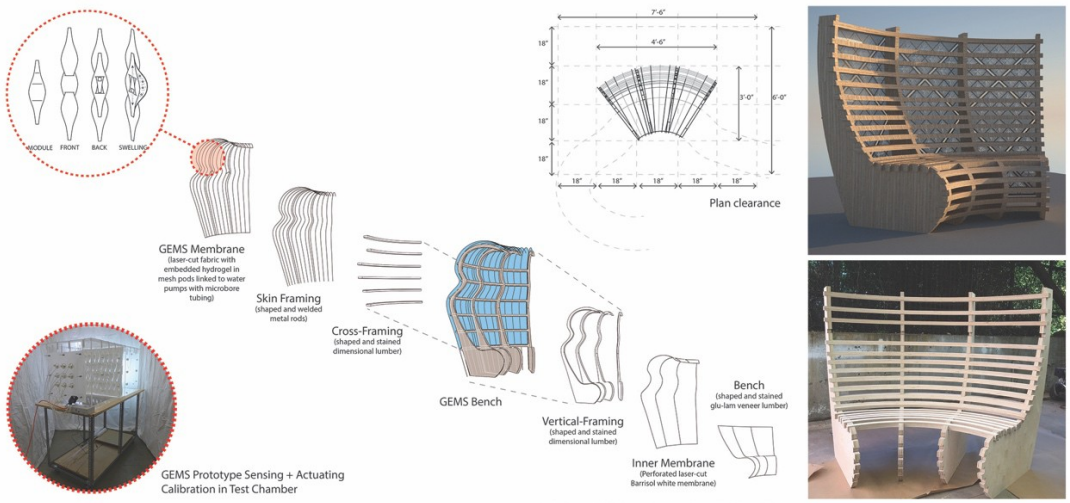
BENCH: Biorhythmic Evaporative-cooling Nano- TeCH

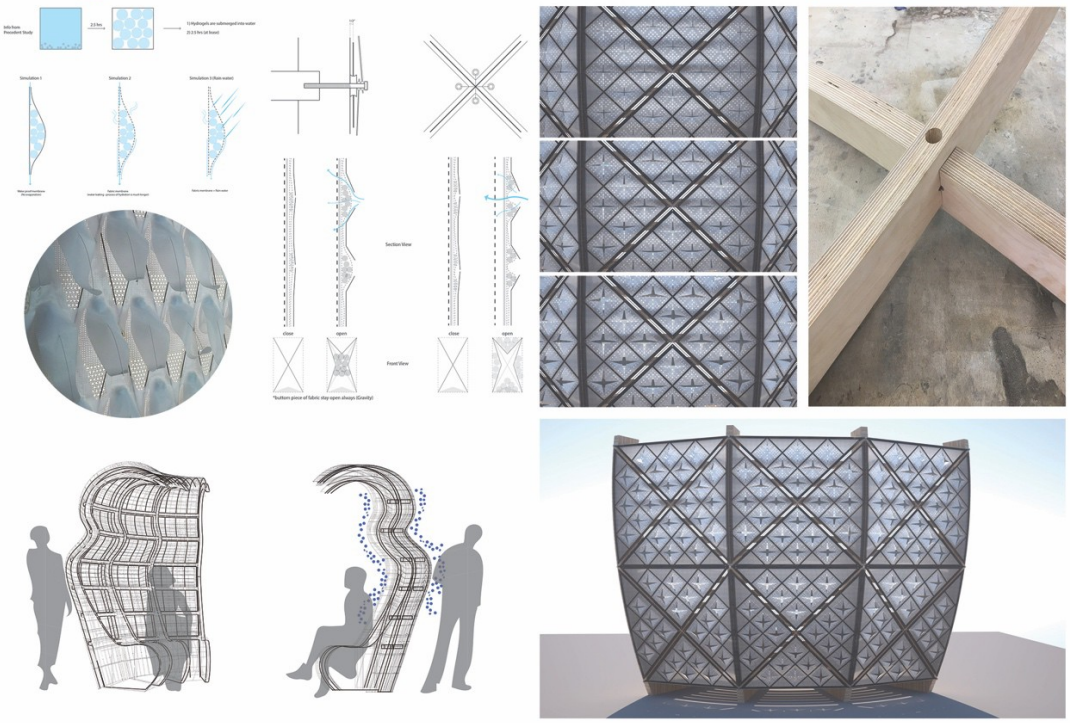
Aletheia Ida
University of Arizona, School of Architecture
Jialiang Ye
University of Arizona, School of Architecture Nick Giambianco
University of Arizona, School of Architecture
Zechariah Fung
University of Arizona, School of Architecture

Abstract

The Biorhythmic Evaporative-cooling Nano-TeCH (BENCH) system is conceived as a novel building skin for architectural enclosures responsive to human interactions for thermal comfort in hot-arid climate conditions. The membrane system concurrently integrates natural ventilation cooling and modulations in daylighting transmission for inhabitant wellbeing and multi-sensory phenomena experience. The BENCH demonstration prototype combines CNC shaped and stained laminated plywood with all wood joinery for the structure of a small covered seating area with atmospheric effects. The soft skin membrane encloses the structure with embedded hydrogels that are actuated with water pumping into the mesh pod modules through clear microbore tubing. Each gel pod module expands during swelling, which induces the lift of an outer flap to allow for airflow through the skin. When air flows through the flaps, it carries humidity off of the gel pods and into the surrounding atmosphere for human thermal comfort cooling effects. There are three small water pumps located under each bench module on the floor. Humidity and temperature sensors are incorporated into the BENCH prototype and link to an automated hydro-pump actuator through Arduino servo motor control. The GEMS prototype is pre-tested with sensing and actuating functionality in an environmental test-chamber in a controlled lab setting. The demonstration prototype is currently being fabricated and will be installed for in-situ real-time testing beginning in May 2019. The project integrates the research and development of the author's work through collaborations with material science, electrical and computer engineering, and human health and wellbeing. Future work with the prototypes includes human wellbeing research in a living-lab setting with non-invasive biometric sensing for heart rate variability and sweat biomarkers in correlation to BENCH environmental fluctuations for temperature, humidity, and dynamic daylight conditions.

Keywords: Hydrogel Membranes, Bioresponsive Design, Evaporative Cooling, Machine Learning, CNC Wood Structure





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Aletheia Ida
University of Arizona
School of Architecture

Jiliang Ye
University of Arizona
School of Architecture

Nicholas Giambanco
University of Arizona
School of Architecture

Zechariah Feng
University of Arizona
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