ZERO-CARBON DESIGN

INDOOR COMFORT

PHYSICAL COMPUTING & INTERNET OF THINGS (IoT)

COMPUTATIONAL DESIGN

BUILDING TECHNOLOGY

CELEBRATING FACULTY AND STAFF SUCCESS AT THE COLLEGE OF DESIGN

CHENGDE WU

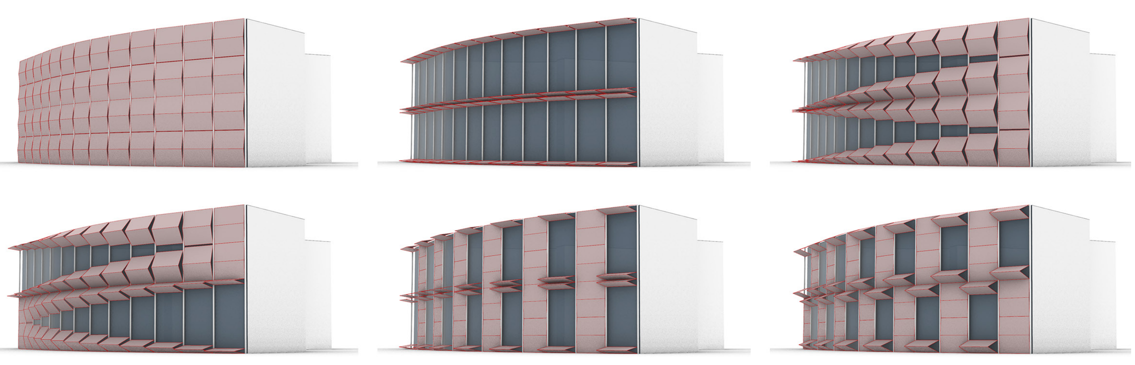
Architecture
Associate Professor

PUBLICATIONS

- 2024 Chengde Wu and Pete Evans. An Integrated System for Improving 3D Concrete Printing Process. IBPSA-USA SimBuild conference, Denver, Colorado. May 21-23 (Accepted for publication)
- 2024 Ehsan Ghaderi, Pete Evans, Shelby Doyle, and Chengde Wu. Hygrothermal Behavior of 3D Concrete Printed Wall Assemblies. IBPSA-USA SimBuild conference, Denver, Colorado. May 21-23 (Accepted for publication)
- 2023 Chengde Wu. Energy Performance Analysis of Kinetic Façades by Climate Zones. In Advanced Materials in Smart Building Skins for Sustainability (pp. 149-165). Cham: Springer International Publishing.
- 2023 Chengde Wu, Shelby Doyle, Nicholas Senske, and Pete Evans. Energy Performance Simulation for 3D Concrete Printed Houses. In Proceedings of ARCC Conference, Dallas, Texas. April 12-15
- 2023 Kyoung Hee Kim, Chengde Wu, Seyedehhamideh Hosseiniirani, and Catty Dan Zhang. Performance Assessment of a Multifunctional 3D Building Integrated Photovoltaic (BIPV) System. In Proceedings of ARCC Conference, Dallas, Texas. April 12-15
- 2023 Elizabeth McCormick, Chengde Wu, MaryGrayson Roberts, and Ok-Kyun Im. Democratized Innovation & Accessible Thermal Testing: The Approachable Hot Box. Energy and Buildings.
- 2022 Chengde Wu, Garrett Herbst, Arturo Lujan, Kyoung Hee Kim. A Stochastic approach to simulate and Optimize the Coating Uniformity of Rotational Molding for Microalgae Facades. In Proceedings of the Symposium on Simulation for Architecture and Urban Design (SimAUD). San Diego, CA. July 18-22

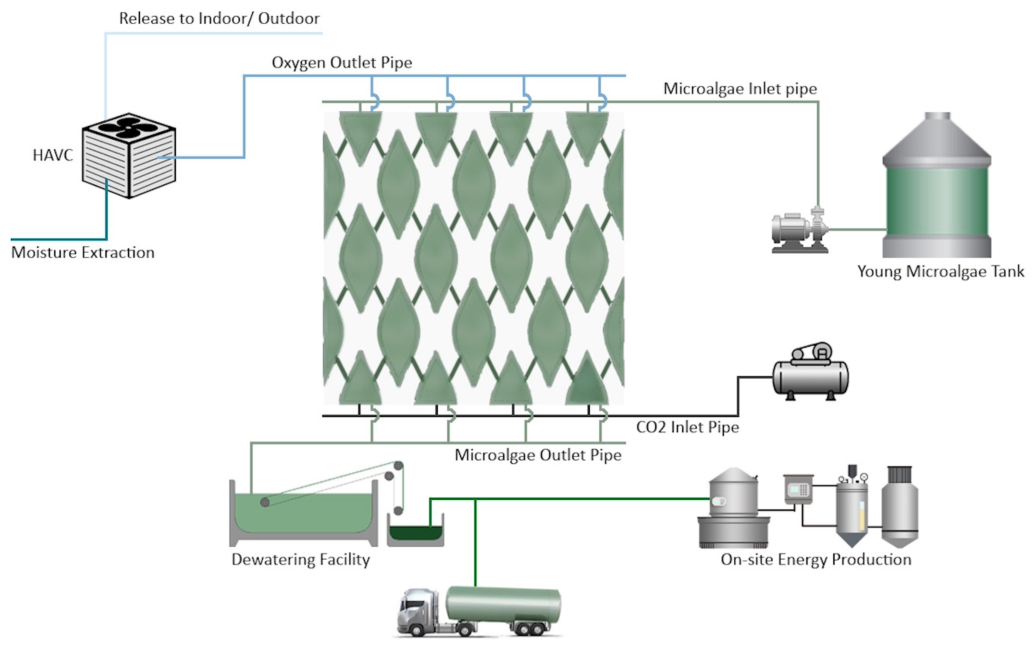
CURRENT RESEARCH PROJECT

SMART BUILDING SYSTEMS



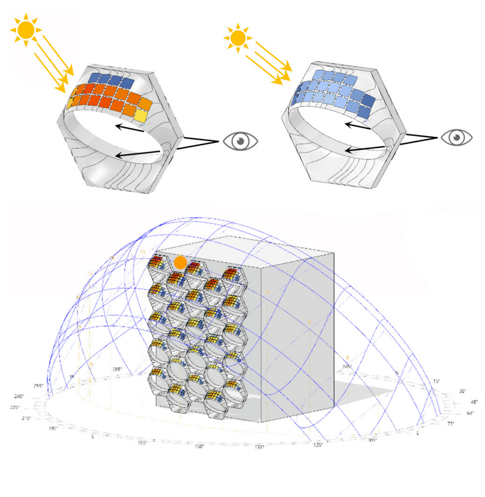
This project investigates smart building systems that provide people with a healthy and comfortable indoor environment with minimal energy consumption. Smart Building Systems utilize a mixture of passive and active strategies, such as thermal mass, passive solar radiation, and kinetic façade, to regulate indoor air quality, thermal comfort, and daylight availability. Smart Building Systems comprise three modules: sensing module, processing module, and actuation module. The sensing module collects environmental data such as indoor and outdoor temperature, humidity, solar irradiance, indoor CO2, VOC, and particulate matter data with corresponding sensors. The processing module utilizes microcontrollers/ microprocessors to process sensor data based on a set of rules or by indexing the simulation database to determine the optimal operation and send the command to the actuation module.

The actuation module physically actuates the smart building components, such as kinetic façades, natural ventilation systems, and heat exchange systems, to optimize building performance. The system is connected to a cloud server that records the sensor data and actuation data which can be displayed interactively in real time. Building occupants can access the cloud system through a QR code and provide feedback on their indoor comfort level, and subsequently the user input will be used for the system to adjust based on the request. This feedback loop helps the Smart Building Systems to easily adapt to different building occupants.



BUILDING-INTEGRATED PHOTOVOLTAICS (BIPV)

This project explores the integration of PV technologies with architectural design process to promote a more disaster-resilient net-zero or net-positive energy building design. The heavy dependency on fossil fuels led to increased carbon emissions and the subsequent negative impacts on the environment. PV technologies can reduce the carbon footprint from emission sources and have made immense advances in the past decade with their prices dropped dramatically. While utility-scale solar farms can produce clean electricity more effectively, damage to the power transmission cable



due to natural disasters can cause massive power outages. BIPV forms clusters of micro electricity grid by harvesting solar energy on the exterior surfaces of the buildings, and thus more resilient to extensive power outages and provides easier access to emergency electricity. This project utilizes computer simulations and physical experiments to identify how to better utilize PV panels compared to traditional rooftop installations. The results of this study can provide BIPV design guidelines to architects depending on the climate conditions of their project sites.

RELEVANT PROJECTS

3D CONCRETE PRINTING PROJECT

This project investigated an alternative solution to build more disaster-resilient and affordable houses by automating the construction process with more structurally sound materials. Our research team has explored the optimization of the hardware and software systems, material mixes, and construction details. The team also simulated the energy performance and hygrothermal performance of 3D concrete printed buildings. The simulation results identified the benefits and caveats of 3D concrete printing regarding its performance.

MICROALGAE BUILDING FAÇADE

This project utilized building windows to grow microalgae for biofuel production. Microalgae needs four elements to grow: water, CO2, light, and a nominal amount of nutrients. Microalgae absorb the carbon dioxide in the room air that is supplied with an air pump, then release oxygen back into the room, and thus improve indoor air quality. The water in the windows acts as thermal mass to regulate the thermal environment while the translucent tint of the microalgae acts as a screen to regulate daylighting. As it grows with CO2 sequestration, microalgae can be extracted for biofuel production.

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