The construction industry is a cornerstone of modern infrastructure but also a significant contributor to environmental degradation. Concrete, one of the most widely used construction materials, exemplifies this challenge due to its carbon-intensive production processes and resource depletion. Addressing these issues requires innovative technical solutions and robust policy frameworks to promote sustainability. This portfolio explores these dual dimensions through two projects: a technical design report on developing a sustainable, 3D-printed concrete canoe and an STS research paper analyzing regulatory and policy interventions for decarbonizing the construction industry. While the technical project focuses on material innovation and construction methods, the STS paper examines the socio-technical systems needed to transition the industry toward sustainable practices. Together, these projects highlight the interconnected challenges of reducing environmental impact while maintaining structural integrity and efficiency in construction.

The technical project, my technical thesis, documents the development of a lightweight, durable, and environmentally sustainable concrete canoe. Initially aimed at pioneering 3D-printed concrete (3DPC) technology, the team pivoted to traditional casting methods due to printer malfunctions, while retaining the goal of mimicking 3D-printed properties. The project involved three sub-teams: Mix Design, Hull Design, and Construction. The Mix Design team explored sustainable aggregates like pumice and puffed shale to reduce weight and carbon footprint, adhering to ASTM standards for compressive strength and slump tests. The Hull Design team developed hydrodynamic curves using AutoCAD and performed buoyancy calculations, while the Construction team designed a post-tensioning system to assemble sectional molds. Key challenges included printer

limitations and material workability, but the project yielded scalable insights for future applications. The team concluded with recommendations for aggregate selection, hull modeling software, and tensioning systems, laying groundwork for future teams to advance 3D-printed sustainable construction.

My STS paper, *Regulatory Frameworks and Policy Interventions in Sustainable Construction*, investigates how policy can drive the adoption of low-carbon practices in the construction industry. Employing a socio-technical framework, the paper analyzes three levers for change: technological innovation (e.g., carbon capture, alternative materials), regulatory pressure (e.g., carbon pricing, waste mandates), and social/economic barriers (e.g., industry resistance, equity gaps). Case studies like the EU Emissions Trading System (ETS) demonstrate how market-based incentives can reduce emissions, while the Resource Conservation and Recovery Act (RCRA) highlights the role of waste minimization policies. However, fragmentation in enforcement and high costs of green technologies remain obstacles. The paper concludes by advocating for integrated strategies, such as shifting proof-of-sustainability burdens to industry and prioritizing community engagement, to accelerate the transition to sustainable construction.

This portfolio underscores the dual imperative of technical innovation and policy reform to mitigate the environmental impact of construction. The technical project demonstrated the feasibility of sustainable concrete design, albeit with adaptations, while the STS research identified systemic barriers and solutions for industry-wide decarbonization. Together, they reveal a critical gap: technological advancements alone are insufficient

without supportive policies and stakeholder buy-in. Future work should explore community-driven approaches to equitable sustainability and refine 3D printing techniques for broader adoption. By bridging engineering and policy, this work contributes to a holistic understanding of sustainable construction's challenges and opportunities.