Thesis Portfolio

A Strive to Net-Zero: Insulation in Residential Housing
(Technical Report)

A Division on the Road: The Safety and Legalization of Lane Splitting
(STS Research Paper)

An Undergraduate Thesis

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Table of Contents

Sociotechnical Synthesis

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Sociotechnical Synthesis

No system, whether social or physical, is perfect. Repair and improvement are naturally expected in the design of any system. Despite popular claims about reliability and performance, every system faces change. Programs and digital applications have updated patches, industrial machines have maintenance schedules, laws have amendments and political positions have elections. Physical and social systems like these are typically designed to meet a certain level of reliability. If the level of reliability is desired or known, "it is a routine matter to determine permissible values for the mean time to repair and the mean time to failure of each component" (Barlow & Hunter, 1960). This indicates a natural preference for predictability in system efficiencies. In order to improve efficiencies and reach closer to perfection, system designs must look beyond routine repair. This thesis will investigate both a technical and sociotechnical application of system designs investing in durability without sacrificing performance.

While the U.S. commercial sector tries to become more environmentally conscious and friendly, the residential sector lacks progress. According to the Office of Energy Efficiency and Renewable Energy, houses built since 2000 consume more energy than houses built in the 1960's (OEERE, n.d.). Heating and cooling accounted for 55% of energy consumption in U.S. homes in 2015. This number is projected to grow as the world becomes increasingly invested in electronic devices demanding power. The residential sector, responsible for 21% of the total energy consumption in the U.S., has ignored environmental considerations.

The capstone project of Mechanical Engineering will convert an existing building to a net zero energy footprint. The University of Virginia Architecture School's Initiative reCOVER building, located at Milton Airfield in Charlottesville, VA, was approved for this project. The building was initially designed for the 1.3 million people left homeless after Haiti's 2010

earthquake (Ford, 2010). It is not equipped to handle Virginia's diverse and seasonal climate. Our team, consisting of Cathryn Palmer, Amelia Kokernak and Jack Pazin, will optimize the insulation of the building to reduce heat loss and conserve energy. Harsha K. Chelliah, a professor in Mechanical and Aerospace Engineering, will supervise our efforts.

The goal is to design a layered insulation system that outperforms and replaces the existing system. The performance will be based on the system's thermal resistance, also known as the R-value. A larger R-value indicates better resistance and less heat loss. The design will also be evaluated on its cost, use of recycled materials, fireproofing and moisture proofing. Due to various climates across the nation, the design will only be applicable to houses in region four of Figure 1.

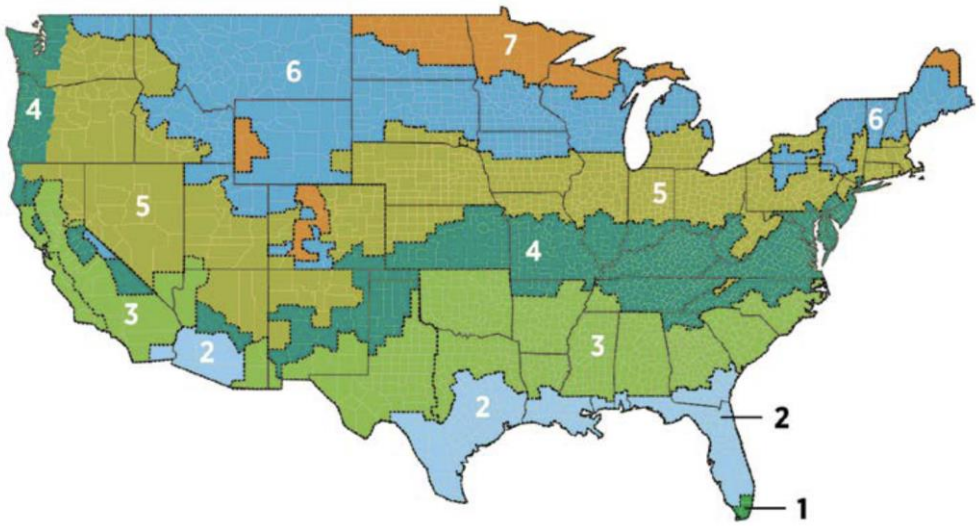

Figure 1. Climate Zones in the United States (OEE, n.d.)

If successful, a layered insulation system will reduce the heat loss and conserve energy in the reCOVER building. The building will be suitable for residents in a climate it was not constructed for. Next steps will include removal of the existing system and installation of the new design.

To investigate sociotechnical system designs, an in-depth analysis will be performed on the validity of lane splitting in the United States. Lane splitting, often referred to with other terminology, is when motorcyclists advance through traffic by riding along the border between two lanes rather than inside the confines of one lane. To assess this action's ability to improve the efficiency and safety of American roads, a multitude of studies and data reports will be evaluated. Since embarking on this project, the legality and presence of lane splitting in the United States has changed. As the status of lane splitting is slowly altering throughout the country, now is the optimal time to conduct an evaluation on its effects.

References

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