# EL SURF Projects for the SURF Program 2021

**Project Description:** The objective of this project is to investigate the role of emergency communications in public response for those under imminent threat from Hurricane Maria, resulting in recommendations to standards and practices to make communities across the U.S. more resilient to hurricanes and other disasters. The selected applicant will work with project advisors to qualitatively analyze emergency messages disseminated to the public leading up to Hurricane Maria on the island of Puerto Rico, and/or interview data with emergency management professionals, as part of an ongoing investigation of emergency communications and evacuation behavior during Hurricane Maria. Expected research tasks may include content analysis, analysis of qualitative findings, and/or identifying major themes in expert decision-making and information shared with the public.

**Project Description**: The goal of this project is to develop elements of digital twin models for intelligent buildings. Digital twin models are software infrastructure to integrate best practices in computer science, such as knowledge representation, reasoning, machine learning techniques, with other engineering models (electrical, mechanical, architectural). The first step in this project involves developing a Building Information Model (BIM) of sample architectural drawings. The next step is to convert that BIM model to a semantic model using the existing well-established ontologies.

**Project Description**: This project focuses on measurement techniques and standards to accurately characterize and understand solar photovoltaic cells under a range of conditions and guide their future research and development. This includes using methods such as spectrally resolved photoluminescence imaging, time-resolved PL, spectral response measurements, current-voltage and power generation measurements. A student working remotely would contribute to interpretation of results, device or environment modeling, or exploration of ideas to improve device efficiency under non-standard conditions as aligned with their interests. Basic programming skills (in a language of the student's choice) will be useful, as well as experience with one or more of: solar cells or physics of other semiconductor devices, optics, or analog circuit analysis.

**Project Description**: The Applied Economics Office (AEO) at NIST works closely with the NIST Community Resilience Program (CRP) and external collaborators to pursue a science-based approach to resilience planning. Resilience and reliability are emerging focus areas in the design of the built environment with the aim of improving preparedness and recovery from disruptive events. More research is needed to understand the planning, protective, and recovery processes of its highly interdependent physical, social, and economic systems. In particular, advancements in measurement science are needed to estimate the economic impact from planned community resilience enhancements that address hazards (e.g., natural hazards, human-made hazards, and other unexpected hazardous shocks and stressors). This SURF opportunity relies on applied modeling, with consideration for field data collection, and statistical and geospatial data analysis. Informed by the combined research of the AEO and the CRP, web-accessible tools are being developed (e.g., the Economic Decision Guide Software – EDGe$ Online Tool) to support community resilience planning. Therefore, strong computer skills, including computer programming, are valued. Continued research is focused upon the emergence of complex event decision-making when there are concurrent and/or cascading risks involved. This research space seeks to identify resilience strategies that achieve other community goals (e.g., economic development, safety, and equity) through co-benefits, some of which may not have a straight-forward market value.
Multiple disciplines will be considered, including engineering (e.g., civil, industrial, operations research, computer science), economics (applied, micro, macro), social sciences (e.g., sociology, planning, decision science), and public health science (e.g., disaster epidemiology, biostatistics).

**Project Description**: The main objective of this project is to explore novel methods of characterization and analysis of additive manufacturing (AM) surface data. The development of AM has allowed for increased flexibility and complexity of designs over formative and subtractive manufacturing. However, a limiting factor of AM is the as-built surface finish. Steep slopes and overhangs create difficulties in the measurement of AM surfaces and existing characterization techniques have proven insufficient. The student will use MATLAB to analyze existing surface data, develop methods to better characterize AM surfaces, assess uncertainty in measurement on characterization techniques, and find correlations between the process parameters used to build AM parts and the resulting surface finish.

**Project Description:** Research in the Infrastructure Materials Group focuses on building infrastructure products (pipes, cables, composites in structures) to determine entire system resilience. Product performance is essential for ensuring consistent operation and predicting continued operation with age and/or after major catastrophes (tornados or hurricanes). This project will focus on the service life for existing and new products (electrical cables) and standardize methodologies and parameters for condition monitoring tests (CMTs). CMTs were used in evaluating commercial products, each exposed to well-controlled exposure conditions. Samples, characterized to establish baseline values, were subjected to exposure environments, measured after each exposure, and assessed for temporal changes in performance. The student is expected to perform following tasks:

1. Review project literature on condition monitoring methods for electrical cables, experimental procedures for chemical and mechanical characterization methods adopted by industry, and procedure to age samples.
2. Review and organize baseline and aged specimen test measurements for statistical analysis of the entire data set. This will include data analysis on select CMTs.
3. Conduct statistical analysis of select data sets to determine if the CMT tracks degradation with aging exposure and summarize results.
4. Assist with arranging the data for the report by revising data tables and updating data trends plots.

Background knowledge and training in engineering or physics, or chemistry. Courses in chemistry (general and organic) and/or physics, and mathematics courses (algebra and calculus) are required. Computer skills, Microsoft Office programs such as Word, Excel and Powerpoint, are also required. Skill for "data analysis, interpretation of measurements results; plotting data" is a plus.

**Project Description***:* Community resilience is the ability to prepare for anticipated hazards, adapt to changing conditions, and withstand and recover rapidly from disruptions. For communities that are acutely exposed to hazards at specific locations, such as riverine flooding and coastal storm surge, voluntary property acquisition programs are an attractive policy for reducing disaster risk and increasing resilience. For this project, the student will analyze data for a buyout program that concluded in 2012. The central research questions are: (1) what motivates homeowners to accept or reject a buyout; and (2) given a homeowner's decision, are they better or worse off after the buyout program?

**Project Description**: An important effort within FDS development has been devoted to have the capability of using CAD derived unstructured geometries within fire simulations. These geometries are defined within FDS by triangulations and the fire dynamics equations are solved around them using the structured FDS grids and polyhedral volumes called cut cells. The philosophy adopted in this effort is that this new capability is an add-on to the reference solver and has to be able to interact to all other functionality present in FDS. As we prepare for a first beta release of these tools, testing of the different components, preprocessing and input, physics, post processing and output of fire simulation need to be tested as much as possible, to iron out issues that will inevitably arise.

Therefore, for this project we would like to have a student who is computer savvy and will learn basics of usage of preprocessors for FDS (BlenderFDS, PyroSym), running FDS in various configurations in our computing clusters, and using the postprocessing visualization tool SmokeView. The student will help us in the important task of thoroughly end-to-end beta testing the described software toolchain.

**Project Description**: The Fire Dynamics Simulator (FDS) is computer model of fire spread and smoke transport that is used world-wide by fire protection engineers for designing fire safety systems in residential homes and commercial buildings. More recently, FDS has been tapped to help understand the problem of wildland-urban interface (WUI) fires. One of the most important parameters for predicting the spread of wildfires is the wind field. But measuring wind fields and comparing the data with the output of computational models is challenging---very few high-quality datasets exist. One such data set is the field campaign from 1982-1983 measuring the wind fields and turbulence characteristics on Askervein Hill in Scotland. In this project, we will be digitizing the data from the 1983 test report, setting up FDS cases, and post-processing the results for the FDS Validation Guide. The student will learn helpful computer skills such as working with Git and GitHub, developing Matlab scripts for Continuous Integration, and compiling professional grade typeset documents in LaTeX. Further, the student will learn the basics of setting up and running a computational fluid dynamics (CFD) model on a Linux cluster for high-performance computing (HPC).