INDUSTRIAL SOLUTIONS LABORATORY

UNC Charlotte – Lee College of Engineering Senior Design Program

Process for Supporting a Senior Design Project

Thank you for your interest in participating in the UNC Charlotte Lee College of Engineering Senior Design Program. The Program's goal is to provide students with industry design challenges as part of their Senior Design academic course. In this capacity, our students gain real world engineering experience while companies benefit from completed work on elective research projects. The ideal project should not be on a critical path for the company ("backburner" projects are good candidates), nor pertain to trade secrets or corporate sensitive information. Project last for two semesters.

The senior design teams typically consist of 4-6 students, a faculty mentor and a technical contact from the industry supporter. We estimate about 250 hours of work output per student over two semesters. The tax-deductible donation to cover the costs of participation is $9,500. $3,250 of this amount is given to the students to cover their material and travel costs for the project. The balance of the donation is to cover the overhead costs of running the Program. This cost covers both semesters. Project expenses in excess of $3,250 will not be authorized unless the supporter agrees to additional funding. Unused material budget money does not roll over to future projects and is returned to the Program to offset overheads. Donations will be invoiced (Net 30) once the Project Description (pages 2-3 of this document) is finalized and the project is accepted and staffed for the upcoming semester – that will be in the Dec 2023 – Jan 2024 timeframe.

As a tax-deductible donation to a non-profit educational program, results cannot be guaranteed, and the project work should not be considered contract engineering.

Our goal is to have Spring 2024 Semester Projects defined by November 15, 2023. There are a limited number of slots, projects are accepted on a first come, first serve basis and once sold out, a project will be put on a waiting list for the following semester.

The documentation (see following pages) required from the industry supporter:

1. Company information for the technical and the financial representatives.
2. A short description of the intended project with expected deliverables/results (Project Description Form). Students will use this information to select their project preferences and Faculty will use it to develop a staffing plan for the project. Examples of completed forms from past projects can be viewed at: https://isl.uncc.edu/senior-design-program/project-examples

Email forms to the Program Director, Jim Hartman (jim.hartman@uncc.edu). If you have any questions or need help defining the scope, please email or call Jim at 704-614-9766.

Project work starts in January 2024 with the Senior Design Kickoff Event on January 17, 2024. This is the first meeting between the team and the industry supporter with the objective being the further definition of the Statement of Work and Specifications for the project. The first semester is the design phase, and the second semester is the implementation/build phase. The teams will meet weekly with their faculty mentor to discuss progress. Supporter technical representatives are invited, at their option, to attend by phone, virtual meeting, or in-person. Each semester, there are the Kickoff Breakfast, two design reviews and an end of semester exposition – attendance of these 4 events (on-campus) is mandatory to ensure awareness and agreement for project direction. The first semester Senior Design Expo is May 1, 2024, and the second semester Expo is Dec 6, 2024. We look forward to your participation in the Senior Design Program!

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Company Information

Company Name	*Insurance Institute for Business and Home Safety*	**Date Submitted**	*12/5/2023*
Project Title	*Mobile hailstone measurement and analysis device (IBHS_HAIL)*	**Planned Starting Semester**	*Spring 2024*

Senior Design Project Description

Personnel

Typical teams will have 4-6 students, with engineering disciplines assigned based on the anticipated Scope of the Project.

Please provide your estimate of staffing in the below table. The Senior Design Committee will adjust as appropriate based on scope and discipline skills.

Discipline	Number	Discipline	Number
Mechanical	4	Electrical	
Computer		Systems	

Company and Project Overview:

Every year, severe weather highlights weaknesses in our building codes, products, and the standards used to rate those products. To reduce future losses, IBHS analyzes existing standards and identifies ways to improve them. The resulting research and insights will influence building codes and standards, which will lead to better products and stronger buildings. IBHS research also provides critical data to improve existing modeling methods and outputs and reduce fraud.

The IBHS Research Center is a state-of-the-art research facility located on a 90-acre parcel of land in Chester County, South Carolina (approximately 45 minutes south of the Charlotte airport). This unique facility enables researchers to evaluate residential and commercial construction materials and systems more fully and accurately under realistic re-creations of severe weather hazards.

The large test chamber at IBHS is easily identified by its enormous wall of 105 fans—each nearly 6 feet in diameter and equipped with a 350 HP engine. Together the fans can replicate realistic weather conditions including Category 1, 2 and 3 hurricanes (with winds up to 130 mph), extra-

tropical windstorms, wind-driven rain conditions, and straight-line windstorms (also called derechos). This structure is a specially designed wind tunnel that is exceptionally large—6 stories tall and 145 feet wide by 145 feet long. This equates to more than 21,000 square feet under the roof, the equivalent of 4½ basketball courts. IBHS is the only lab in the world that can test full-scale one- and two-story residential and commercial buildings in a controlled, repeatable fashion for highly realistic windstorms, wind-driven rain, hailstorms, and wildfire ember storms.

Figure 1: IBHS test chamber

This facility is also a tangible, public demonstration of the property insurance industry's deep commitment to reducing and preventing losses that disrupt the lives of millions of home and business owners each year. The research conducted here significantly advances building science and influences residential and commercial structural design and construction, helping to create more resilient communities.

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Figure 2: Ember exposure (left) and wind driven rain (right) tests.

Project Requirements:

Hail can occur in any strong thunderstorm, which means hail is a threat everywhere. Damage caused by hailstorms is one of the costliest expenses for homeowners and business. Total insured annual loss from Severe Convective Storms in the US was over $50 billion and hail accounted for
80% of it. IBHS and its members recognized the growing problem of hail damage in large regions of the U.S. and have devoted years to ongoing field and lab research to develop a new test standard for impact resistance. An invaluable part of this research is the attempt to characterize the material and analyze the behavior of individual hailstones. Size, density, and impact strength are characteristics that play a huge role in how much damage can be expected. Having access to data on how hailstones behave upon impact allows engineers to develop improved protective/shielding features.

While it is possible to make sample hailstones in a lab, the process itself is slow and does not yield samples with true natural densities and shapes. Therefore, it is common practice to collect these samples during or shortly after hailstorms have already occurred. IBHS deploys the only active field research team dedicated to studying hailstorms to help improve detection, forecasting, and modeling capabilities of hail. As a part of deployment, they will measure the size of hailstones, weight them, and then perform a compression test to determine at what force the stones will fracture. This is done manually and one stone at a time, making it a very slow and labor-intensive process for the people working in the field.

The objective of this project is to develop a prototype for portable unit that can autonomously perform all required measurements mentioned above and do so at a fast pace. Ideally, the technicians would be able to load a hailstone into this machine, and then the ma-

chine would measure the hailstone diameter, weigh the sample, and perform a compression test. Upon completion of the compression test, the remains of the crushed hailstone would be removed from the machine (preferably automatically), and the technician can immediately load another stone to be measured. These hail stones are of considerable size: the machine should be capable of performing tests on stones with diameters between 0.5'' and 3 ''. The data for each of these tests should be saved automatically (a cable connection to a laptop with a simple LabView program is sufficient). As this unit must be portable, it must be battery powered.

Expected Deliverables/Results:

- Prototype of portable hailstone measurement machine.
- LabView program for measurements, data storage, and (optional) data analysis
- Demonstration of functionality by testing the machine on lab generated hailstones (provided by IBHS) or ice cubes.
- CAD models and engineering drawings for all designed structural components, as well as component specifications for all sensors/actuators.

Disposition of Deliverables at the End of the Project:

Students are graded based on their display and presentation of their team's work product. It is mandatory that they exhibit at the Expo, so if the work product was tested at the supporter's location, it must be returned to campus for the Expo. After the expo, the team and supporter should arrange the handover of the work product to the industry supporter. This handover must be concluded within 7 days of the Expo.

List here any specific skills, requirements, specific courses, knowledge needed or suggested (If none please state none):

- Mechatronics
- Automation
- Machine Design
- CAD