**Introduction**

Modern day transportation relies heavily on large scale infrastructures such as: bridges, tunnels and overpasses. In particular, bridges serve to connect civilizations and provide a vital \_\_\_\_\_\_\_. Because of this, it is important to maintain a high level of safety. Because of this, these structures require careful maintenance and monitoring. The term structural health monitoring (SHM) refers to the process of identifying and mitigating damage to engineering structures.

In the case of suspension bridges, the addition of cables under tension makes monitoring the structure a unique process. In general, suspension bridges when properly cared for have long service lives. The main cables used to support the hanger cables are composed of cable bundles which are wrapped in soft wire and painted for protection. The wires are also galvanized, and when combined with the wrapping, offer good protection from the elements (Pure Technologies #). However, as mentioned by Higgens in his report, “a well-documented vulnerability has manifested itself on several bridges in the United States: corrosion of main cables” (Pure Technologies). Corrosion in the main cables is the primary reason for cables failing and snapping in the main bundle. When enough cable snaps occur, the loading capabilities of the bridge can be compromised. Proper monitoring of the bridges and their cables can help to keep the bridge in operation over large periods of time. However, this is a costly and labor intensive process.

According to a report by Pure Technologies on the Bear mountain Bridge ”A current visual inspection method[s] of a 10ft length of cable, wedging down 5 inches at 8 points around the circumference, only exposes one side of 4000 linear feet of weave, or 0.007% of the total length” (Pure Technologies #). It should be noted that this method requires an observer, to visually inspect the wire. It was found that using this method to expose, inspect, and reinstate the cables costs on the order of $2 million dollars for 320ft (Pure Technologies #).

Newer methods for autonomous to semiautonomous monitoring would be beneficial in reducing the cost and labor involved in detecting these cable snaps. Using sensors to detect when and where cables snaps occurred could provide rapid health assessments of the structure, allowing mitigation steps to be taken. One possible method is to use acoustic monitoring sensors.

Acoustic monitoring has the potential to be able to detect breaks in suspension cables. Breaks in the cables create measurable acoustic events than passive systems can detect. In addition, active systems can inject signals into the bridge cables, having the sound travel the length of the wire. This method of monitoring holds the potential to greatly reduce or eliminate the need for cable inspection until a snap occurs. Furthermore, depending on package design, acoustic sensing could greatly reduce cost of operations.

**Problem Statement:**

The Rhode Island Department of Transportation has displayed interest in the development of a system that can detect and locate cable failures on the Newport Claiborn Pell Bridge. This study looks to determine the viability of an acoustic monitoring sensor system for detecting snaps or breaks in suspension cables. After researching the two methods of detection, active and passive sensing, a system package would be designed for the chosen method.

**Project Focus:**

* The Project is split over two semesters, or two phases
  + Phase 1: Frequency Identification
    - It is important to consider which frequencies have the greatest ability to travel the long distances of the bridge.
    - It is necessary to consider how the grouping and clamping of the wires found on the bridge will affect the frequencies propagating down the line.
    - In phase 1, an experimental study was completed to determine the most viable frequencies to drive the sensors with
  + Phase 2: System Design and Application
    - An active sensor package was developed to send acoustic signals down the suspension cables
    - The system was applied to both an in house test bed and the Newport/Pell Bridge
    - Results were gathered and analyzed

**Concept Generation:**

The decision on whether to use active or passive sensing was made by doing an extensive literature and patent search. As a brief