

Problem Definition

Motivation:

- Increasing frequency and severity of flooding isolates communities
- Floodwaters damage infrastructure, preventing access to roads and traditional rescue procedures
- Rescue boats struggle in shallow water leaving dangerous gaps for evacuees to cross
- Evacuees often face life threatening risks when forced to enter moving or contaminated flood water



Requirements:

- One-sided deployment from rescue boats without requiring evacuee assistance
- Ensure user safety, supporting multiple occupants and preventing slips
- Prevent direct interaction with floodwater during operation
- Be durable, waterproof, and reusable in harsh environments

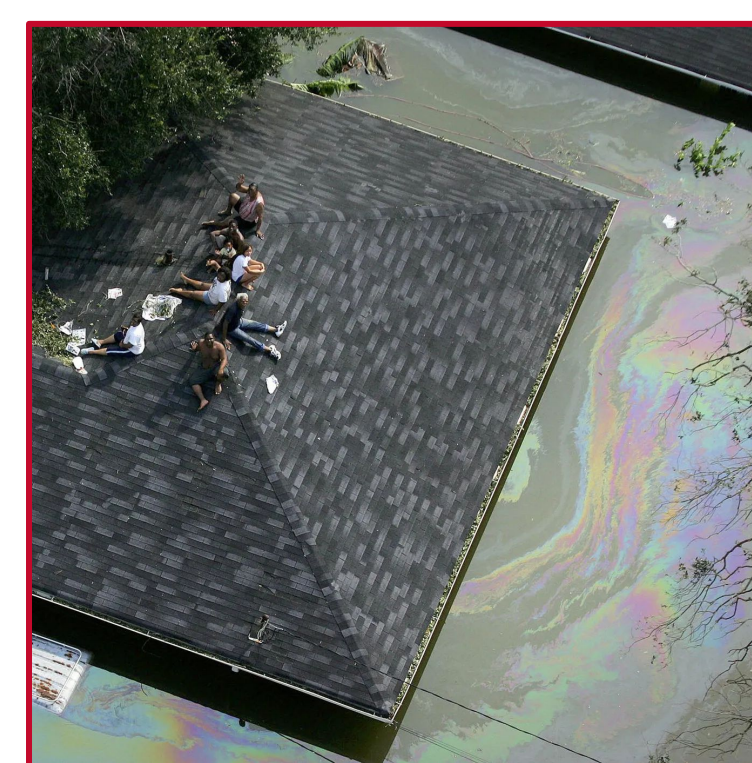
Goals:

- Safely transports evacuees from hazardous areas
- Provide rapid deployment and operation to minimize rescue time in critical situations
- Enable access to evacuees in both shallow water and elevated locations (rooftops)

Impact

Risk Mitigation:

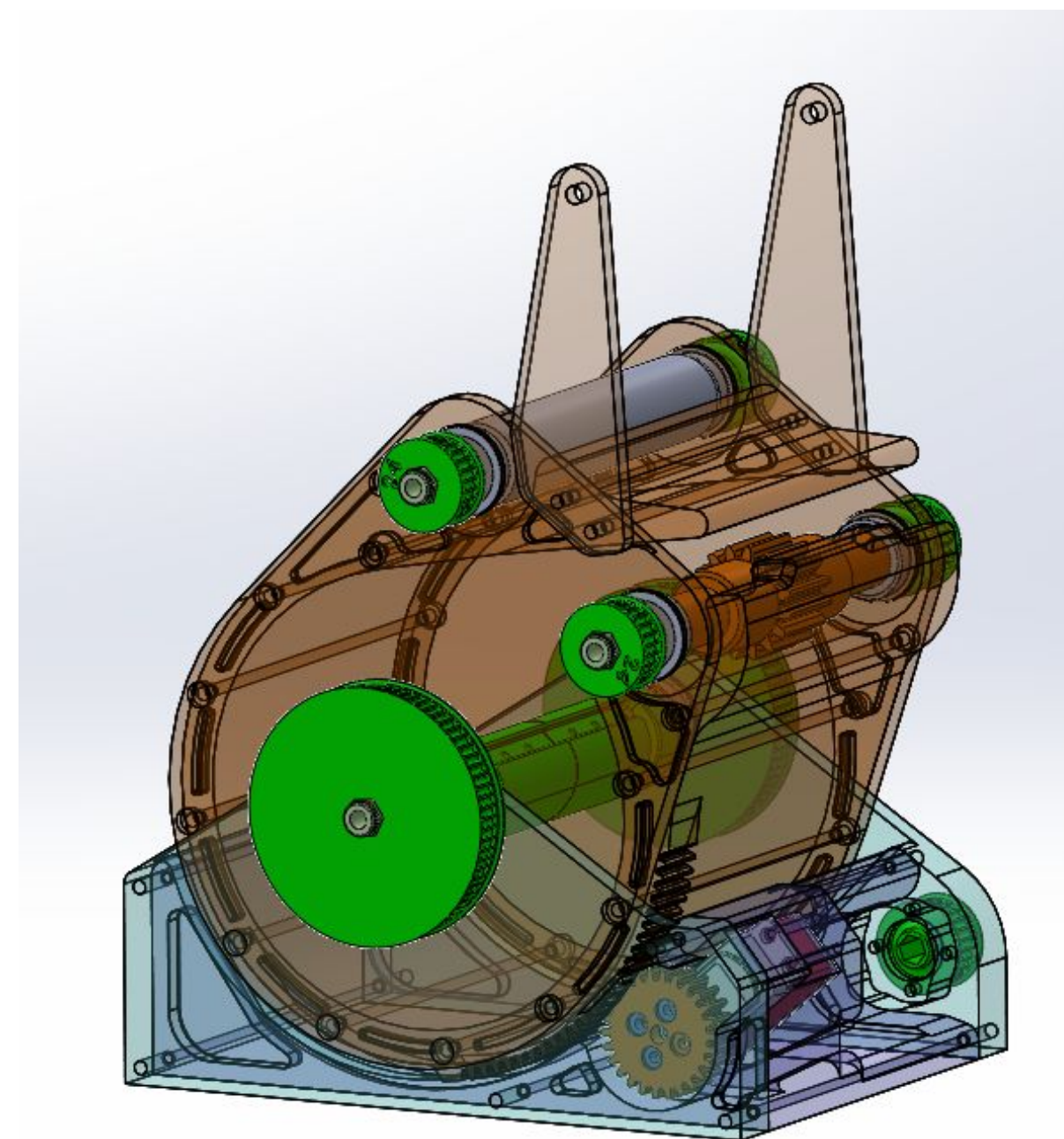
- Allows evacuees to reach rescue boats without direct contact with floodwater
 - ↳ Minimizes health issues caused by industrial, chemical, and biological pollutants found in floodwater
 - ↳ Reduces risks posed by hidden hazards like subsurface currents, potholes, sharp objects, or submerged electrical lines
- Ensures first responder safety, preventing them from becoming victims themselves and facilitating further rescue efforts
- Increases perceived safety to improve evacuee cooperation and expedite rescue operations



Sustainability:

- The materials used are environmentally friendly, so no additional contaminants will be introduced to the surrounding environment
- The design is reusable and modular, lowering total costs over time and allowing for rapid replacement of worn parts
- Each link consists of widely available 4x4 wooden beams
 - ↳ This reduces production costs and, thus, retail prices
 - ↳ Lower prices improve accessibility in low-income areas
 - ↳ More units can be bought to accelerate rescue operations

Final Design



Base Subsystem

- Structural Housing
 - Contains motors, electronics, and support structure
- Servo Motor (Pitch Control)
 - Provides precise position control of canister angle
- Mounting Interface
 - Secures system to jon boat

Canister Subsystem

- Bridge Storage
 - Accommodates up to 60 links in compact configuration
- Rack and Pinion Drive System
 - Provides controlled and accurate bridge extension
- Central Drum
 - Enables compact and consistent stowage of links
- Cable Coil System
 - Allows upper cables to deploy and retract without tangling
- Belt Transmission
 - Synchronizes all three drive systems for proper deployment timing

Bridge Subsystem

- Routed Yellow Pine Links
 - High-strength
 - Lightweight
 - Cost-effective
 - Rack routing integrated into link geometry
- Upper Cable Guard Rails
 - Provide additional support during cantilever loading
- Cleat Plates
 - Secure lower cable and prevent slipping
- Final Link (End Effector)
 - Includes hooks for engagement with rooftops

Prototype



- 1/8th scale
- 3D printed structure
- Paracord represents steel cables
- Servo actuated pitch
- Brushless motor with planetary gearbox for extension and retraction
- Aluminum hooks at end effector

Functions, Uniqueness

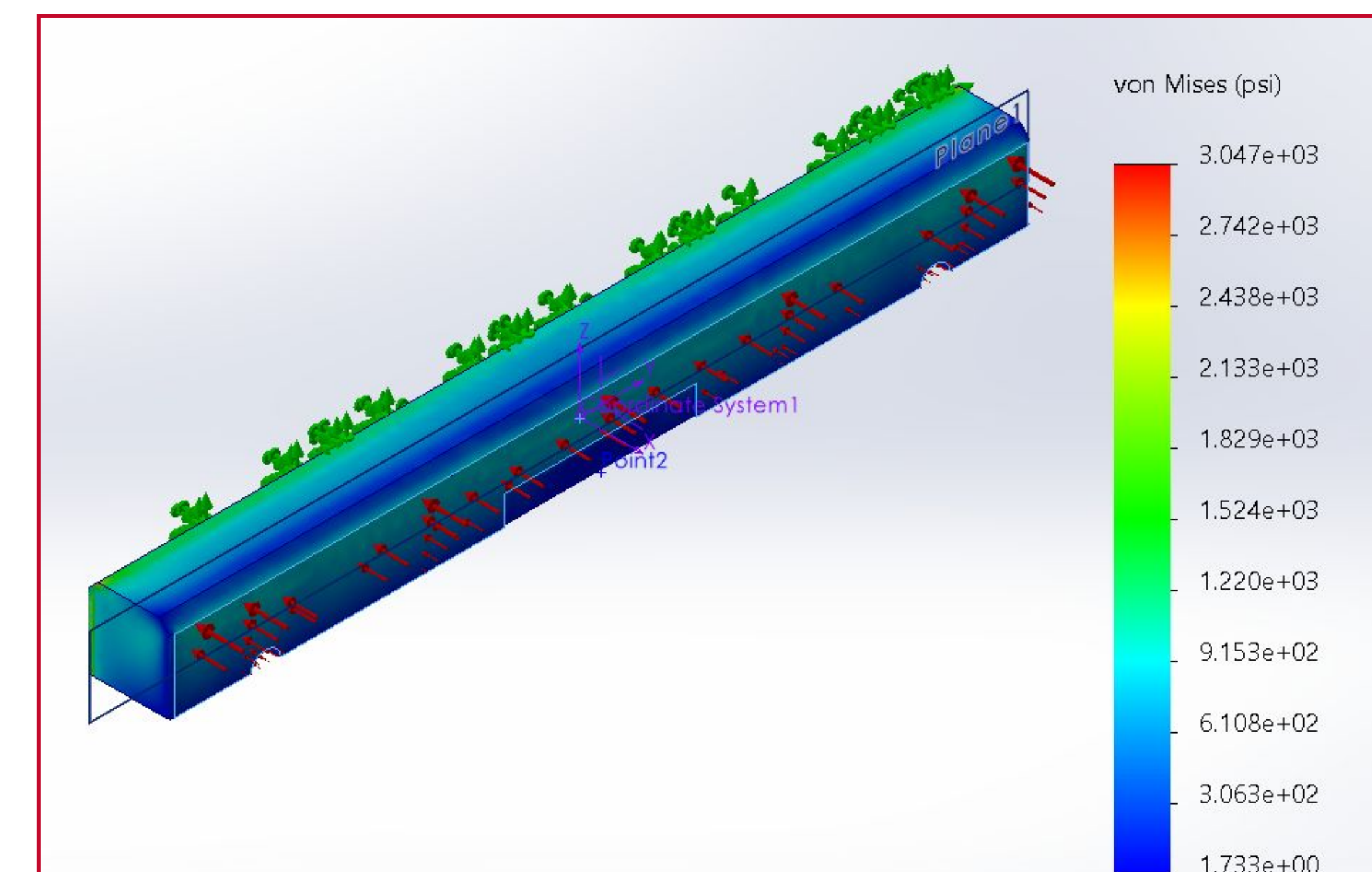
Operations Procedure:

- Emergency responders arrive on scene
- Anchors and tie-down ropes are secured
- The bridge is oriented toward evacuees and extended
- Once sufficiently extended, a controlled drop secures the hooks to the rooftop
- Upper support cables are checked to ensure proper tension for safe traversal

Key Features & Uniqueness:

- **Compact Portability**
 - Deployable bridge system designed for transport and storage on a rescue jon boat
- **Automated Deployment**
 - Integrated extension and retraction system for rapid setup
- **User-Friendly Operation**
 - Minimal personnel training required for effective use
- **Modular Architecture**
 - COTS Components designed for quick replacement and upkeep

Validation



- FEA simulation verifies hand calculations performed
- Most critically stressed component in our product
- Safety factor of 1.67 is achieved