

# Ship Recycling Robot

Joseph Cybul (CS/RBE), Noble Kalish (CS), Joshua Hoy (ME/RBE),  
Isabel Morales Sirgo (ECE/CS), Tyler Reiser (CS/RBE)

Advisors: Professor Berk Calli (RBE/CS) & Professor William Michalson (RBE/ME/ECE)

## Rationale

- The global ship breaking and recycling industry is responsible for reclaiming the valuable metal and components in expired ships of all sizes.
- The process to recover these assets often puts workers in dangerous environments. According to US OSHA standards, ship breaking operations expose workers to a wide range of hazards likely to cause injury or illness including:
  - Asbestos
  - Polychlorinated biphenyls (PCBs)
  - Lead
  - Hazardous material and chemicals



## Objectives

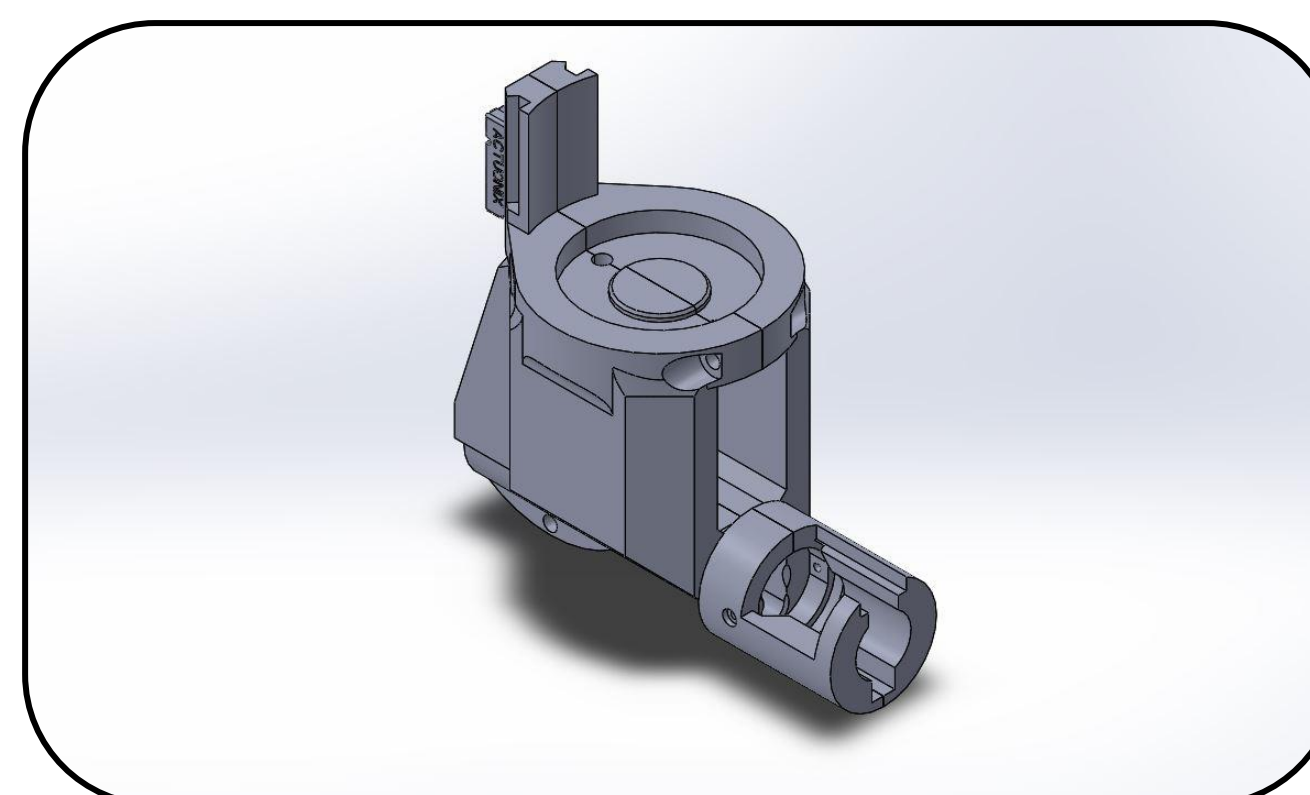
1. Research current limitations and issues with manned ship breaking
2. Design cutting mechanism with vision guidance system
3. Implement design on Franka Emika Panda robotic arm
4. Test cutting conditions to determine optimal cutting parameters

## Future Improvements

1. Mobile base for lateral movement
2. Integration onto Embedded system for portability
3. Auto-tuning of torch flame using machine learning
4. Adapt system to work with a larger arm

## Custom Torch Attachment

- Provide arm with stable grip on torch
- Easy to disassemble/assemble
- Actuator to control oxygen flow through torch
- Centers gravity of torch to reduce stress
- 3D printed lightweight PLA fire-resistant plastic



## Testing the Cutter

### Setup:

- Motorized linear slider to control torch
- Adapted attachment from arm to hold torch

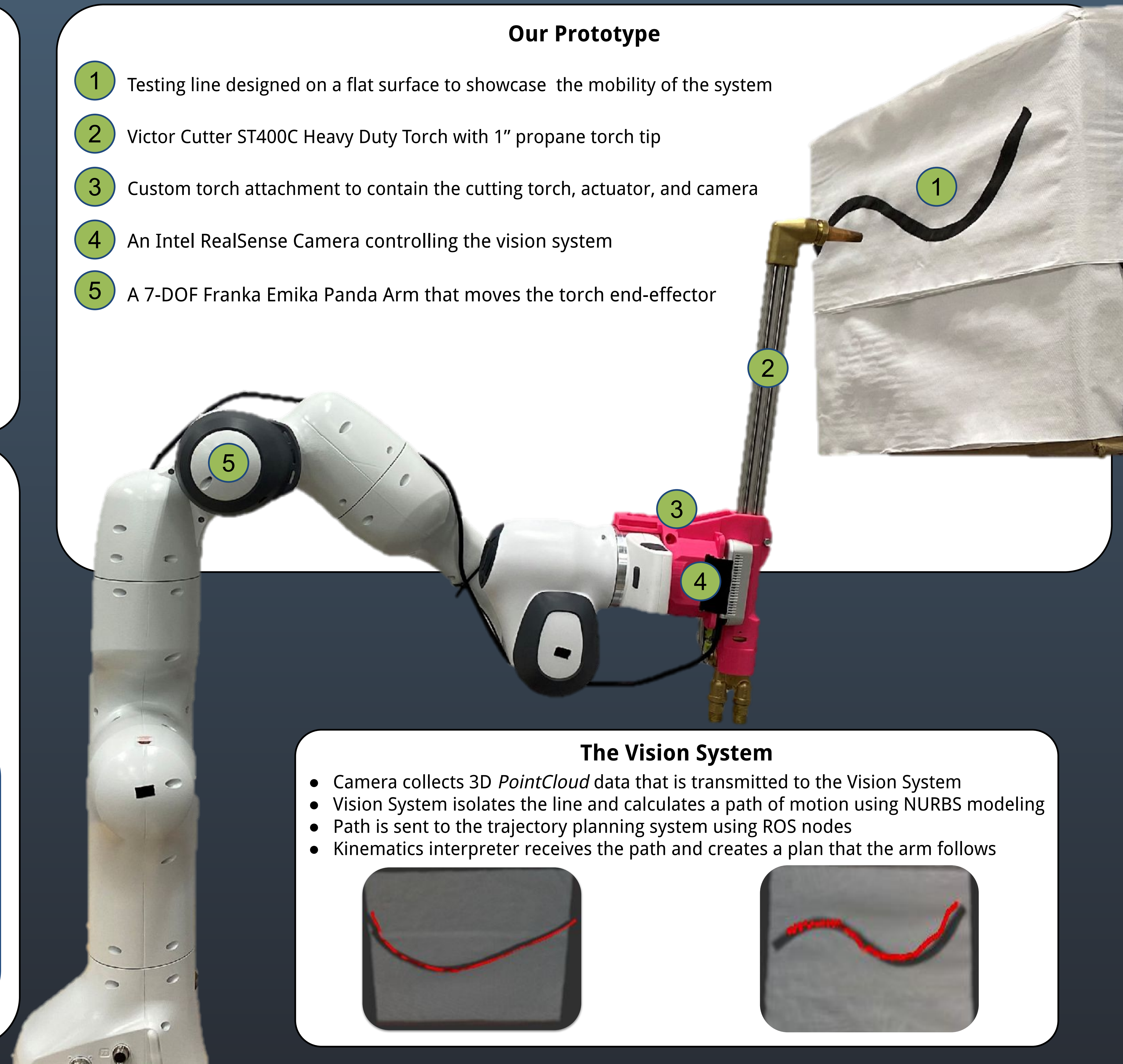
### Testing Conditions:

- Optimal oxygen and propane pressures for cutting **30PSI/8PSI**
- Best distance from cutting material **.25"**
- Optimal speed for cutting **0.06in/s**



## Our Prototype

- 1 Testing line designed on a flat surface to showcase the mobility of the system
- 2 Victor Cutter ST400C Heavy Duty Torch with 1" propane torch tip
- 3 Custom torch attachment to contain the cutting torch, actuator, and camera
- 4 An Intel RealSense Camera controlling the vision system
- 5 A 7-DOF Franka Emika Panda Arm that moves the torch end-effector



## The Vision System

- Camera collects 3D *PointCloud* data that is transmitted to the Vision System
- Vision System isolates the line and calculates a path of motion using NURBS modeling
- Path is sent to the trajectory planning system using ROS nodes
- Kinematics interpreter receives the path and creates a plan that the arm follows

