To Predict ▶ To Design ▶ To Perform

College of Engineering
Department of Mechanical & Industrial Engineering

ME, ECE, BE Capstone Design Programs

Team 29: Closed-loop Hydraulic Robotics Lab

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Subsea Tieback Foundation

Background

- The Subsea Tieback Foundation is committed to raising awareness of the subsea industry through outreach at schools and universities.
- This project is the fourth capstone design project at LSU, each relating to outreach.
- The initial inspiration for this project was to repurpose a previous capstone project and develop it into an educational lab at Louisiana State University.

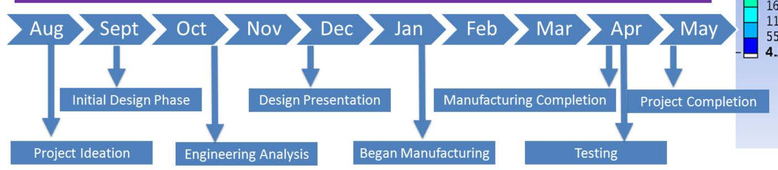
Project Goals

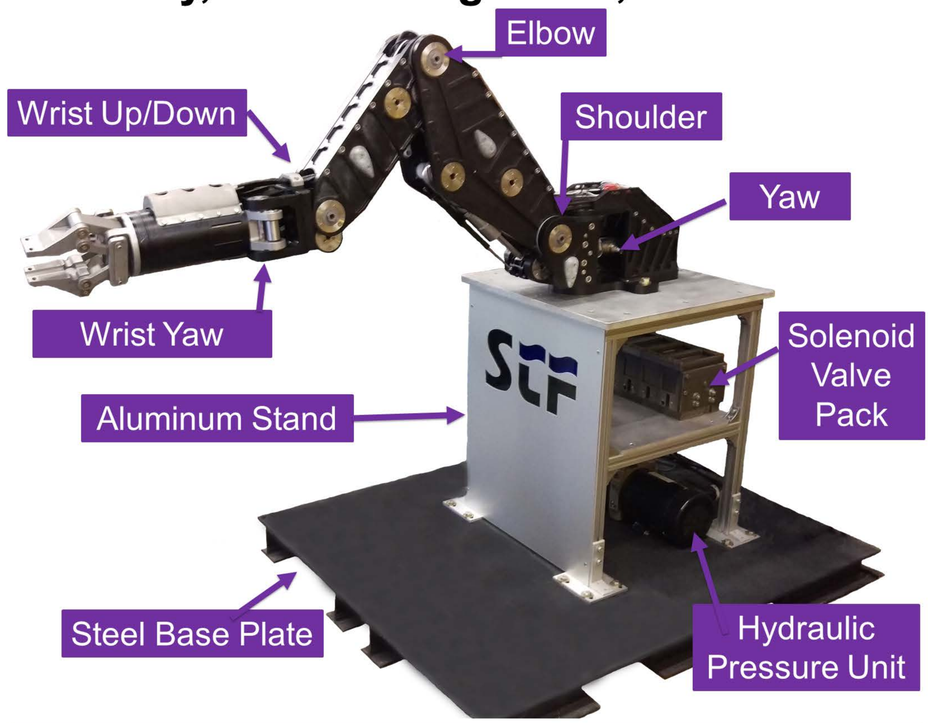
- Deliver a fully operational robotic manipulator arm capable of running on a closed-looped system.
- Develop a series of educational labs to reinforce knowledge of engineering principles.
- Promote the subsea industry through the use of lab.

Engineering Specifications

Engineering Constraint	Description
<1500 psi	Max Hydraulic Pressure
0-10V	Sensor Voltage range
<180◦F or 82◦C	Max Hydraulic oil Temperature
<32” width	Allow for placement into Robotics lab
1GB ram / 2.8 Ghz	LabView Minimal Requirements
24V	Input for Given Valve Manifold
3.44”	Stroke Length of Actuator 1
5.38”	Stroke Length of Actuator 2
1.69”	Stroke Length of Actuator 3
100lb min.	Lifting capacity
10%	Allowable error of repeatability

Timeline



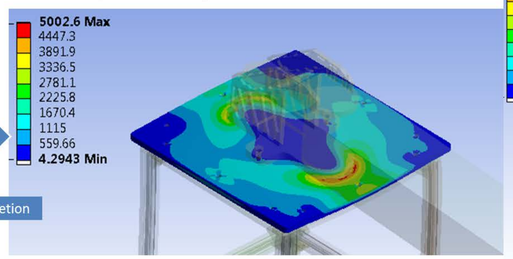


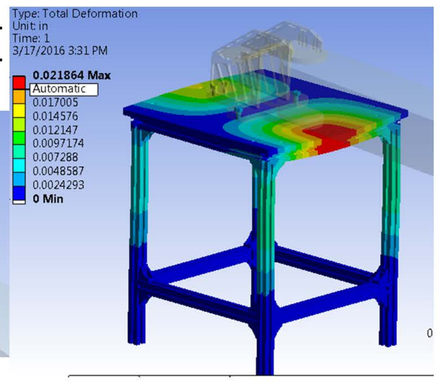
Educational Labs

- Kinematics-based lab where students calculate gripper position and test using the manipulator arm.
- Programming lab where students use LabView to program simple robotic movements in the closed-loop system.

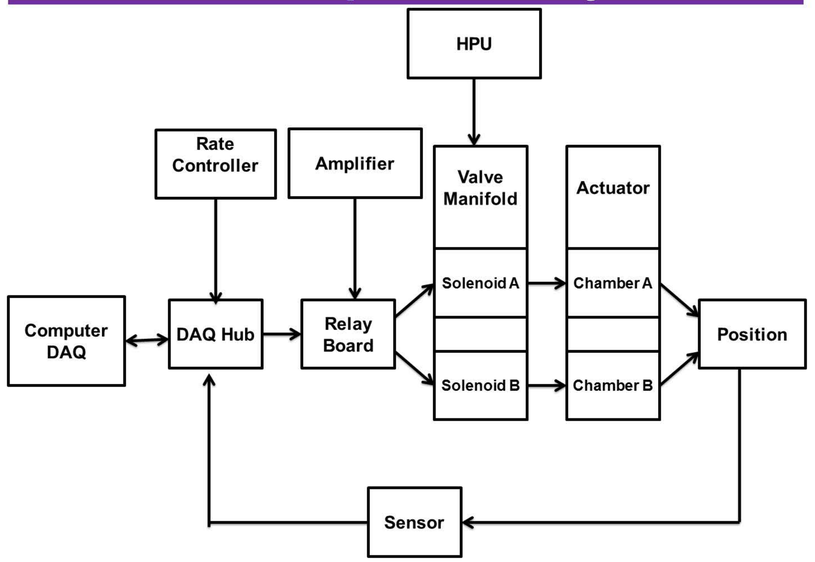
Analysis

- Structural analysis of stand/base plate.
- Kinematic analysis of manipulator arm.
- Lifting capacity of manipulator arm.

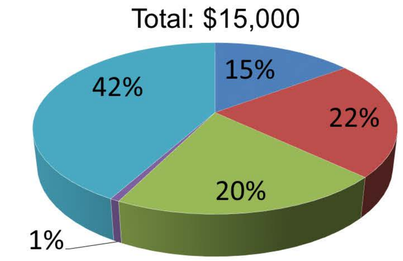




Closed-Loop Control System



Budget



Sensor	$2,222.51
Electronics	$3,324.70
Structure	$3,062.32
Hydraulics	$105.44
Surplus	$6,285.03

Testing and Results

Testing

- Tested system functionality to ensure all parts were operating correctly.
- Tested accuracy of closed-loop motion for each actuator.
- Tested temperature range of Hydraulic Pressure Unit during operation.
- Tested lifting capacity of manipulator arm.

Results

- Accuracy of actuators fell within specified limits.
- Close-looped operation enabled hands-free control.

Actuator	Average Error (degrees)	Average Percent Error
Yaw	2.71	4.17
Shoulder	1.7	3.74
Elbow	1.45	1.41
Wrist U/D	1.6	0.95
Wrist Yaw	2.38	7.32

Sponsors: Ryan Keller, Michael Mannino, Don Wells, Peter Tran

Advisors: Dr. Marcio De Queiroz