Team 9

Endress+Hauser Imagination Station Museum Unit

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Customer Background

Endress+Hauser:
They are a lead supplier of products, solutions and services for industrial process measurement and automation. The sensors being utilized include the Picomag Flow Sensor and the Micropilot level radar sensor.

Imagination Station:
This is a nonprofit organization that is a museum for children that focus on activities and exhibits that teach about space, science, and technology.

Problem Statement

Develop, construct, and evaluate a process automation demonstration system aimed at displaying the Endress+Hauser sensors' capacity to illustrate key aspects of fluid mechanics. This Demonstration System is intended for use by children at the Imagination Station science center. The in unit must be interactive, engaging, and highlight these process automation sensors.

Requirements

Composed of key components addressed by Imagination Station and Endress+Hauser

From Imagination Station:
These factors come from the need for safety and engagement from the students that visit the imagination station.

- Water-tight
- Fixed Structure
- Kid Proof
- Interactive
- Size Requirement
- Colorful and Engaging

From Endress+Hauser:
These factors are needed to properly integrates and use the sensors provided by Endress+Hauser.

- Utilize Sensors Functions
- Display Sensor Readings

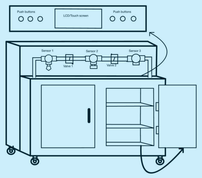
Using these requirements, a decision matrix and FMEA was created to help narrow down design choices and analyze risk and form a mitigation plan.

Experimentation and Concepts

Sensors

Picomag: Display the flow of the water that is being pumped from the splash zone to the main area.
Micropilot: Measures the peak/trough levels of the waves. Movable across the top of the tank and values displayed through the Endress+Hauser app.

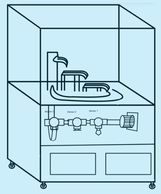
Concept One



This design featured a tabletop with water under the top. The water would be watched while going through the different pressure and flow sensors.

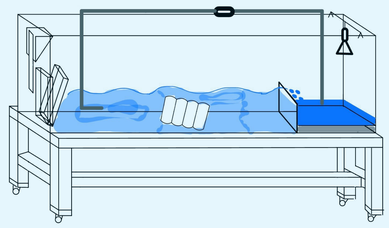
Concept Two

This design used a waterfall effect to create an interactive element where the pressure and flow would be measured going from the bottom to top of the waterfall



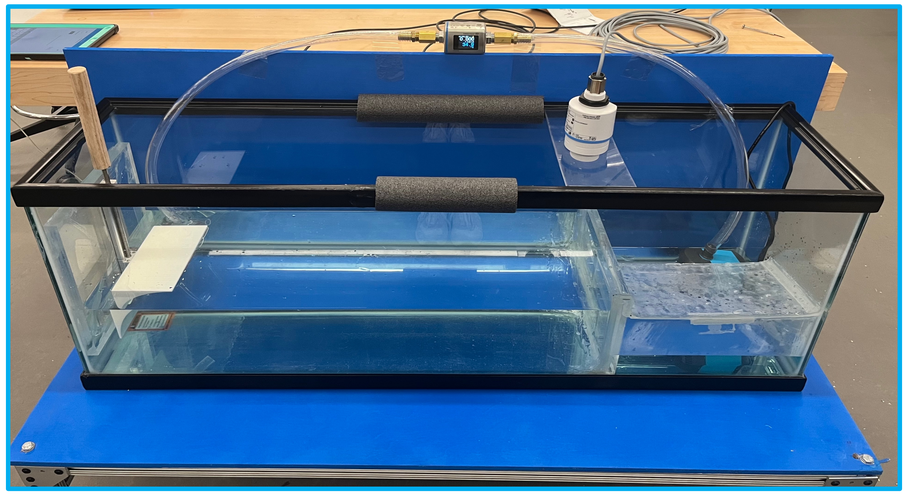
Wave Tank

- Waves are generated by a hand pump where the user can control the speed and size of the waves.
- These waves reach the end wall were they splash over into the splash pool.
- Break waters can be placed in the tank to create breaks in the waves, changed the end height of the wave.



Final Design

The final design features a 50-gallon fish tank that has been modified to house a wave tank, and a overflow splash area. For the wave tank, waves are produced mechanically through a wedge that is moved up and down by the student. This allows for the student to choose the wave height and speed. The waves can be broken up by breakwaters placed in the tank before the splash wall. Above this zone is the Micropilot, which uses radar to measure the height in the wave. Once the water splashes over, it is pumped back into the main part of the tank and through the Picomag flow meter to see the flow speed of the water.



Calculations

Calculations were done to find the correct pump and tank size. This insured the pump would move the water fast enough to get a reading on the Picomag, and for the tank to keep in the splashing water.

Calculations	Results
Tank	V = l * w * h = 48.5" x 12.5" x 18.75" = 11367 in^3 (50 Gal)
Pump	Aoucom submersible pump, 20 W
Velocity (V)	400 GPH, 1500 L/H
Requirements	Water fills 1/3 of tank. 1/3 * 50 gallons = 17 gallons
Water Weight	25 gallons = 141 lbs
Assumptions	Tank won't leak and water won't splash over
Time	Time to fill up tank = water amount / pump velocity = 25 gallons / 400 gallons per hour = 0.0625 hrs * 60 mins = 3.75 mins * 60 s = 225 seconds
Recommended	Use 16-17 gallons of water in tank to make it 1/3 full and stable.

Testing

Wave Generator:

In the initial design, the wave generator was going to automatically create the waves. After multiple rounds of testing, we found that the electric driver and actuator did not produce enough force and move fast enough to create the desired waves. From here, it was decided to create a mechanical version of the wave generator. Overall, it adds an interaction element to the unit.

Sensors:

The Picomag and Micropilot have a simply designed integration. The sensors were tested both individually and, in the system, to ensure readings were as expected.