Group 19:

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CUSTOMER BACKGROUND

Endress+Hauser is a global leader in measurement instrumentation, services, and solutions for industrial process engineering. Endress+Hauser works with Purdue University Polytechnic Capstone group to promote learning in interactive hands-on projects. They supply all of the necessary learning materials and unique parts for the best quality projects from engineering technology students. The mentors at E+H work one on one with the students and go above and beyond in ensuring that we get the most accurate information in a timely manner.

PROBLEM STATEMENT

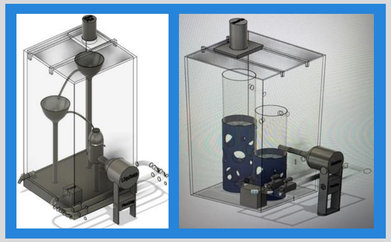
- Design, build, and test a portable process automation demonstration unit.
- For the redesign, we have a base, but will make improvement on the tubing materials, the pump, and the drainage system.
- By making these changes we will have a sustainable unit that will stay intact through travel and remain durable.

Req. #	DESIGN REQUIREMENTS	DESIGN TARGETS	VALIDATION
	RATIONAL		
1	Portable for Demonstrator	All pieces of the demostration system and case equal 40-50 lbs or less	All sensors, materials, case, and any other equitment when combined weighs less than 40-50 lbs
	Weight is large contributor to the portability of the unit. The more managable the weight, the easier transportation will be for the demonstrator		
2	The unit to demonstrate characteristics of the process medium	The sensors will need to check flow, level, pressure, temperature, and pH of the unit.	The unit will a use Micropilot FMR10, Liquicap FMI51, Picomag Flow Meter
	Displaying the characteristics of the unit is important to teach K-12 and college students the basics of fluid mechanics. The purpose of the unit is to showcase Endress+Hauser sensor usability		
3	Process medium needs to accessible, disposable, and work with the sensors	The system will operate with water as the medium	The system will be able use water as the process medium, and easily dispose of the medium for clean up.
	Water is one of the most readily aviable process mediums. It is non toxic, and acessible in schools, offices, or other places where the unit will be used. Water can also be disposed with ease down any drain. Water is compatible with the sensors.		
4	Any electrical for the unit will need to access a 110V outlet	The demonstration unit can be plugged into any oultet in a room and be fully operational.	When you plug in the unit into multiple outlets, it will work in every one of them
	A 110 V outlet is standard for US power outlets.		
5	The unit needs standard operating instructions	An instruction manual outlining assembly, disassembly, packing, and troubleshooting	The demonstator will be able interpret work instructions for an assembly/disassembly and complete it in under 30 minutes
	A manual will create a defined way for using the unit and troubleshooting for any potential issues.		
6	Pressure Sensor - Cerabar	This device will be able to accurately read and transmit the pressure information	Validating the Cerabar will come from testing this product for functionality and using the pump to create to read known pressure values.
	One of the important fluid values requested by E+H is the pressure information inside of the system.		
7	Level Sensor - PicoMag	This device will need to accurately read and transmit the level information.	In order to validate the PicoMag, the team will be checking the distance measurements against known height values to check for functionality.
	A fluid value requested by E+H is the level information of the unit.		
8	Flow Meter - Micropilot	This device will have to accurately read and transmit the flow rate information	Validating the functionality of the flow meter will come from usin the pump and expected flow rates to measured values.
	The flow rate of the unit is a requested value from E+H.		
9	A pump will be needed to move the fluid through the system	This pump will large enough to meet all flow rate minimums of the fluid sensors from E+H	The pump will be tested for appropriate flow rate values and then tested in tandem with the fluid sensors
	The pump will need to output the expected flow rate in order for the sensors to operate. The pump is critical to the functionality of the unit.		
10	The unit will need to be leak proof	The unit will need to unable to leak during or after use. The connection points between tubing and sensors will need to be sealed.	The unit will be assembled, filled, and assessed for any leakage of the process medium.
	Leakage was the critical issue for the previous group, any sort of leakage would not be improving the other iteration. Leaking is also an issue for keeping the operational.		
11	The unit will need a travel enclosure	The travel enclosure will need to be large enough to fit all components as well as protect it from travelling stresses it could encounter	The travel enclosure will need to be able to fit inside of trunk of a car or on an airplane for travel. The unit will be placed in the case and impacted test for durability.
	If the enclosure is unable to protect the unit, it has the chance to break during travel or be too large to travel efficiently		

EXPERIMENTATION AND CONCEPTS

LASER CUTTER EXPERIMENTATION

Laser Cut Parts
- Micropilot Rails
- Picomag/Cerabar Stand pieces
- Fountain Holes
- Casing Holes

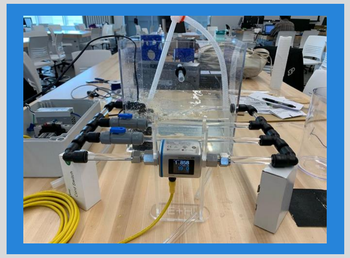


FIRST AND SECOND CAD SOFTWARE CONCEPTS

PORTABLE DEMONSTRATION UNIT 2022

INITIAL PIPE LAYOUT CONCEPTS

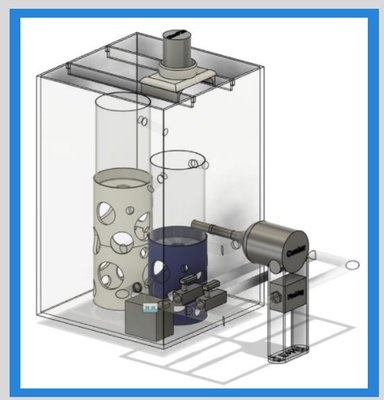
TESTING

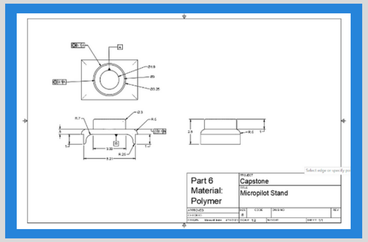


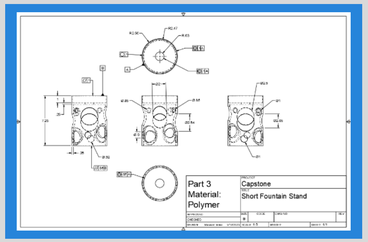
The testing phase of the project consisted of operating the system and checking for leaks with the seals, tubing, and fittings. The three primary sensors were checked for proper connection and operation.

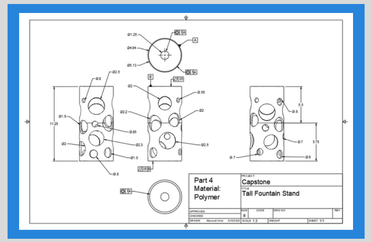
FINAL DESIGN

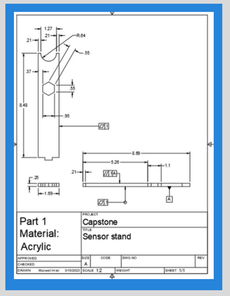
FINAL CAD DESIGN AND CUSTOM PART MECHANICAL DRAWINGS

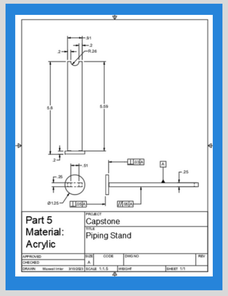


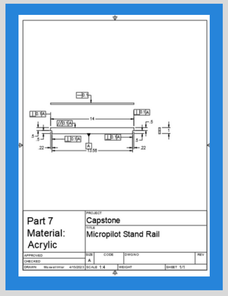












FMEA

DESIGN FAILURE MODE AND EFFECTS ANALYSIS (DESIGN FMEA)

PLANNING AND PREPARATION (STEP 1)			
Company Name	Endress + Hauser	Subject	
Engineering Location	Greenwood,IN	DFMEA Start Date	11-Nov-22
Customer Name	None	DFMEA Revision Date	11-Nov-22
Model Year(s)/Platform(s)	Capstone 2022-2023	Cross Functional Team	2023 Capstone Class

	Continuous Improvement	STRUCTURE ANALYSIS (STEP 2)			FUNCTION ANALYSIS (STEP 3)			FAILURE ANALYSIS (STEP 4)				RISK ANALYSIS (STEP 5)				
Issue #	History / Change Authorization (As Applicable)	1. Next Higher Level	2. Focus Element	3. Next Lower Level or Characteristic Type	1. Next Higher Level Function and Requirement	2. Focus Element Function and Requirement	3. Next Lower Level Function and Requirement or Characteristic	1. Failure Effects (FE) to the next Higher Level	Severity (S) of FE	2. Failure Mode (FM) of the Focus Element	3. Failure Cause (FC) of the Next Lower Element or	Current Prevention Control (PC) of FC	Occurrence (O) of FC	Current Detection Controls (DC) of FC	Detection (D) of DC	RPN (S x O x D)
		Portable Demonstration Unit	display unit	Pump	Demonstrates movement water	products are shown how they are used	the products are mounted in the correct manner	the unit leaks	8	the tubes connectors got worn out	tube connectors	buy different connecters	5	their is water on the ground	6	M
			Endress + Hauser	tubes	Transports with ease	Can fit in a case	can be taken in and out of case	pump is not pumping water	6	the pump is not strong enough	pump	look at many different pumps to get the best one	4	water is not moving	5	L
			products		Does not leak	the tubes are detachable	the tubes are clear	Not being able to drain water	5	water could spill out	tank	get the correct tank	7	water is on the ground	7	M