

E+H & PPI High School Automated Assembly Line

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Customer Background

Since being founded in 2017, Purdue Polytechnic High School has created an innovated approach to education. Where students from all backgrounds learn through hands-on STEM- focused projects and real-world experiences. Inspiring and empowering students to pursue their passion while creating skilled achievers and creative thinkers.

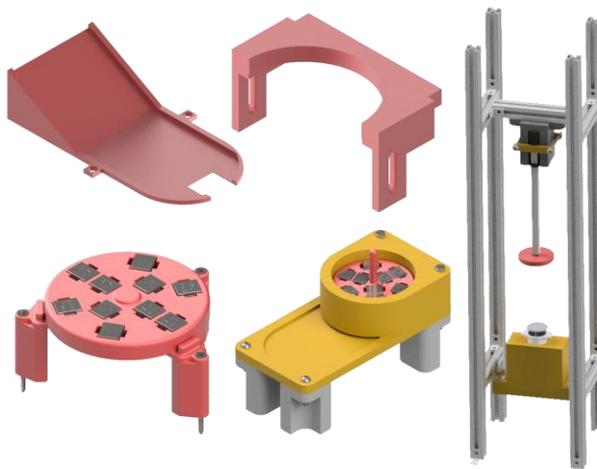
Problem Statement / Scope of Work

The objective of this project is to develop an assembly line for coasters, to be used at Purdue Polytechnic High School. In terms of final product performance, the produced coaster must have a previously chosen design printed on them and must be of good quality. The entire assembly process must run accurately and efficiently, in addition to being an engaging and educational experience for the students.

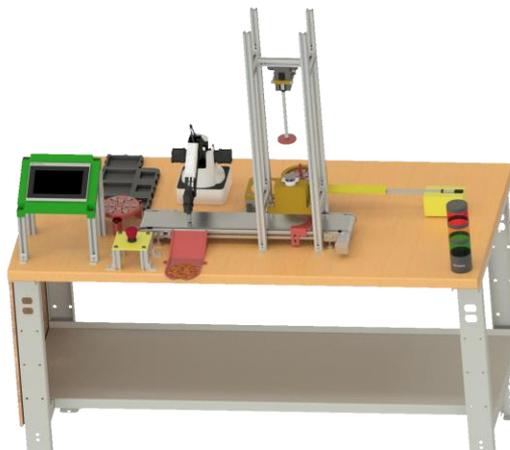
Requirements Matrix

Req. #	Requirement	Description	Test to Verify
1	Design on Coasters	The final product will be able to produce a coaster with a design	Visual inspection to ensure the design is present
<i>Rational and Reference: According to the project catalog, the client wants coasters to stamp a design.</i>			
2	Shape of Coaster	The coaster parts must be circle shaped.	Visual inspection to ensure coaster is circular
<i>Rational and Reference: Leads to a zero-waste system, making it much more efficient.</i>			
3	Permeability of coaster	The coaster must be water-resistant to sustain the condensation of a drink	Simulate usage by placing coaster with condensation atop of the coaster for 24 hours
<i>Rational and Reference: To achieve the function of the coaster, the condensation of drinks shouldn't affect the surface underneath the coaster.</i>			
4	Ergonomic Requirements of the Assembly Table	Table height must be set within a range that is comfortable for the end users	User testing and observation
<i>Rational and Reference: The overall Assembly Table must adhere to standard ergonomic requirements by being set at a height that is comfortable for the end user</i>			
5	Durability of Coaster Design	The design transferred on the Coaster must be durable and remain true to its intended form	Leaving the coaster submerged in water for 24 hours
<i>Rational and Reference: The final design on the Coaster must be resistant and durable, of good quality, and remain unchanged when submerged in a liquid for a period of 24 hours</i>			
6	Fit through a standard door size of 36" W x 80" H	The tabletop design must fit through a standard door size when moving the design	Measure the length and height of overall design.
<i>Rational and Reference: When transporting the design, the cart must be able to pass through various doorways to reach its destination in the classroom.</i>			
7	Reusable assembly line process	The design must function as an assembly line	Test design's function, compare it to other sources
<i>Rational and Reference: The client wants the product to act as an assembly line that produces prints onto cook coasters.</i>			
8	Coaster Size	The coaster size must fall within the Standard Size in North America for Restaurant Coasters, which is within 3.5in-4in in circumference	Statistical Quality Control studies on random samples produced by the Assembly Line
<i>Rational and Reference: The Assembly Table and Process must produce final products that fall within the specified upper/lower limits</i>			

Experimentation & Concepts



Final Design



FMEA

FMEA - Failure Mode and Effect Analysis									
Key Process Step	Potential Failure Mode	Potential Failure Effects	S E V	Potential Causes	O C C	Current Controls	D E P T N	Action Taken	
Coaster Dispenser - Function consists of storing coasters to be used in the assembly process, as well as feeding them into the system									
Feed a single coaster unit into the system	>1 coaster units are fed into the system	Critical Failure, Overfeeding the Assembly Process	6	Actuator Misfire	4	Actuator Misfires would most likely be caused by an input sent by code	2	48	Linear Actuator programmed to feed only one coaster into the system per cycle
Handshaking with the PLC and Robot	Code for synchronization and unification of sub-processes in the System	Unresponsiveness and idle behavior due to not being in sync with Robot and PLC	7	Wiring Issue	7	Ensuring the wires which are leading the handshaking are connected prior to starting the assembly process setup	3	147	Current wiring was investigated and improved, a new wiring diagram was created to document the correct and working wiring scheme
Coasters must be fed sequentially, at the start of each Assembling Sequence	Coasters are fed sporadically in between ongoing Assembly Sequences	Critical Failure, Assembly Sequence and Flow disruption	5	Actuator Misfire	4	Actuator Misfires would most likely be caused by an input sent by code	2	40	Code has been tested and refined, correct code has been documented

Testing

Test ID	Test Name	Results	Pass/Fail
1	Design on Coaster	Newly implemented StazOn ink pads led to good quality and long-lasting design prints on the coaster	Pass
2	Shape of Coaster	Inspections on the current batch of coasters led to the conclusion that all coasters are the correct shape	Pass
3	Coaster Permeability	A 500ml water bottle was left on top of a newly produced coaster for a week. The results showed that the design remained unchanged and there was no sign of moisture build up in the cork	Pass
4	Resemblance to Actual Assembly Line	The process has a clear start and finish, with multiple steps in between to get to the finalized product. Everything is automated and is running well without any errors/interruptions	Pass
5	Coaster Size	Inspections of the current batch of coasters led to the conclusion that all coasters are the correct size	Pass
6	Assembly Line Process	Multiple random iterations of the program were run, and all of them ran from start to finish, without errors or any interruptions/errors	Pass
7	Repeatability of Process	Multiple random iterations of the program were run, and all of them had the correct output sequence for Design and Color	Pass