PAINT SYSTEM REDESIGN

Christian Horton, Terry Ratliff, Matt Seasor, Lauren Wiegand
Design Engineering Technology
Advisor: Dr. Jenkins

INTRODUCTION

Ashley Industrial Molding is a plastic molding and coating company with customers across the nation. In order to coat the plastic parts in paint, the company operates a large-scale paint booth system. The system slowly moves parts through each process and paints each one either by hand or with the help of robotic painters. Due to inefficiency in the heating, ventilation, and air conditioning system (HVAC), the company has issues with safety, quality, and increased downtime. Figure 1. shows the current paint booth during a down moment. A solution will ideally save the company resources, money, and time while also improving safety for workers.

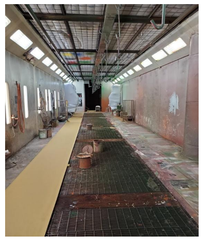


Figure 1: Paint Booth

PROBLEM STATEMENT

Ashley Industrial Molding presented the team with an issue in the system concerning the ventilation, fans do not pull paint particles out of the air in an effective or efficient manner (see Figure 2). Due to the inefficiency of the ventilation system, parts are often repainted due to stray paint particles from previous paint jobs. In order to prevent this quality error from happening on a large scale, the team at AIM will clean the system by hand. This system cleaning creates 2 hours of downtime per day, creating a minimum 8 hours of downtime per week. Workers also complain that the paint booths are uncomfortable due to lack of airflow, high temperature, and paint fumes. The problem wastes precious time, money, and resources for the AIM team.

Figure 2. Paint Clogged Fan

CUSTOMER NEEDS/SPECS

Customer Needs	Rank	Ventilation Width	Fan Speed RPM	Wall Material	Filter Material	Type of Fan	Dehumidifier	Floor Material	Depressurized Air Cleaner	Downtime of Paint Change	Part Setup	Type of Ventilation (Water	Filtration System
Safety of the Top Coat Area	3				1	3	3		3			3	
Better Airflow/Ventilation	5	5	5	3	1	5	5	3	5			3	5
Less Paint Sticking in the Air	5	3	3	1	5	3	5	1	3			5	5
Decrease Downtime	1					3	5		3	3	3		5
Efficiency/Throughout	1		1			3	5		3				
Eliminate Defects	1	3	1		3	3	5			3			5
Importance		43	42	20	36	58	68	20	54	6	3	43	60

Value Scale

Strong	5
Medium	3
Weak	1

Figure 3. House of Quality Chart

The design team created a house of quality to capture the customer needs and technical requirements, Figure 3. Of note from this chart are the priority of dehumidifiers, filtration system and type of fans. As seen in Figure 2, a significant issue lays with paint clogging the system.

RELEVANT RESEARCH

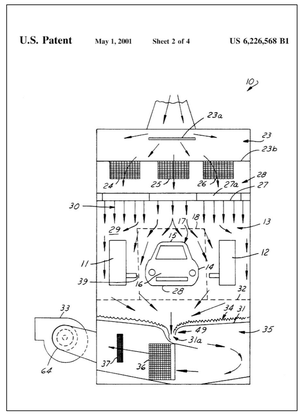


Figure 4. Air Flow Prior Art

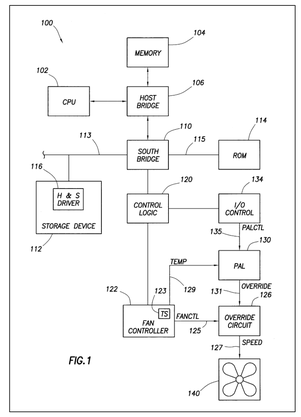


Figure 5. Control System Prior Art

The team research relevant existing systems to aid in creating solutions. Figure 4 is a method of rapidly balancing air flows in a complex paint spray booth having a series of cells. While Figure 5 is designed to help cool down control panels, by having a fan blow through the control box that way it doesn't get too hot.

DESIGN CONCEPT

Figures 6 and 7 are screenshots of the completed paint booth that the team designed. Figure 6 shows the new HVAC extending straight up instead of having two 45 degree turns. The floor, Figure 7, is extended past the original floor to create a "door" to eliminate the tornado like airflow.

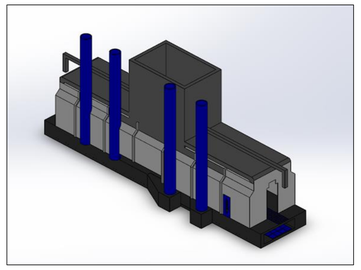


Figure 6: Designed Paint Booth

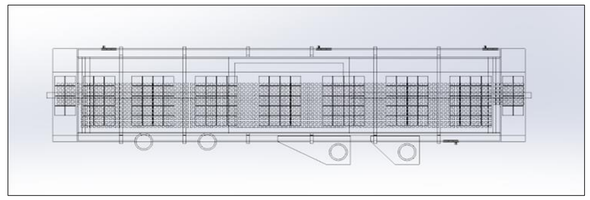


Figure 7: Top View of Paint Booth

CURRENT BOOTH SPECS

- The spray booths aren't reaching minimum requirements for downdraft (FPM). Manual spray zones require at least 100 FPM. The actual downdraft was calculated to be operating at 13 FPM in the prime spray booth and 33 FPM in the topcoat spray booth.
- The prime spray booth has a design of 51,200 CFM (30K AMU) and the topcoat spray booth has a design of 112,000 CFM (100K AMU).
- The prime spray booth is 12,231 CFM negative because of the differential between the supply and exhaust volume. The topcoat spray booth is 13,200 CFM negative because of the differential between the supply and exhaust volume. Regarding the topcoat booth, this is contributing to heat leaving the entrance of the oven.

FUTURE WORK

The team will be testing the current paint booth in certain areas to determine where the paint booth lacks in meeting customer specifications. Airflow is the major source of error; therefore the team was provided with airflow specs, see Figure 8.

FUTURE WORK CONT.

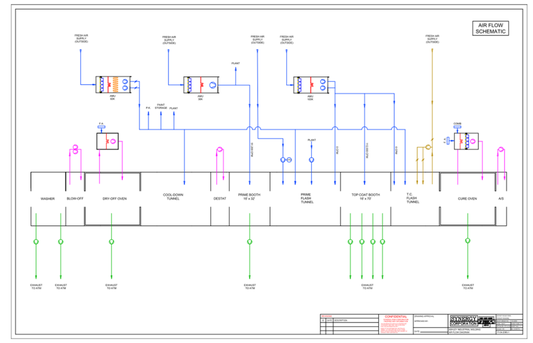
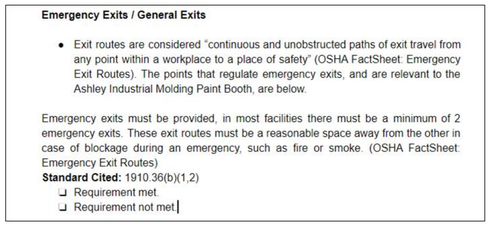


Figure 8. Airflow Schematic

The team will be generating a checklist as a direct way to explain which standards should be met according to OSHA requirements. This will be given to the AIM executives for reference. A sample of the standards used are in Figure 9.



Emergency Exits / General Exits

- Exit routes are considered "continuous and unobstructed paths of exit travel from any point within a workplace to a place of safety" (OSHA FactSheet: Emergency Exit Routes). The points that regulate emergency exits, and are relevant to the Ashley Industrial Molding Paint Booth, are below.

Emergency exits must be provided, in most facilities there must be a minimum of 2 emergency exits. These exit routes must be a reasonable space away from the other in case of blockage during an emergency, such as fire or smoke. (OSHA FactSheet: Emergency Exit Routes)

Standard Cited: 1910.36(b)(1,2)

- ❑ Requirement met.
- ❑ Requirement not met.

Figure 9. OSHA Checklist Sample Question

LESSONS LEARNED

The team learned how to become experts in a field with no prior knowledge to the field when starting this project. This and how to properly communicate with the sponsor about the initial scope of the project could have helped benefit the team more. The team also struggled with knowing what to ask in the beginning to get started and learned to ask the right questions as time went on.

ACKNOWLEDGEMENTS

Dr. Jamie Canino, Mechanical Engineering, Field Specialist.
Prof. Tom Trusty, Design Engineering Technology, Department Chair.
Joe Keeler, Scott Pflughoeft, Dick Boxell; Ashley Industrial Molding.

Ashley Industrial Molding
"AIM" for Excellence