

IOWA STATE UNIVERSITY

Department of Agricultural and Biosystems Engineering (ABE)

TSM 416 Technology Capstone Project

Silicone Applicator Cleaning Improvement

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Client: Cardinal Glass, 716 NE 6th Street, Greenfield, IA 50849

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1 PROBLEM STATEMENT

Problem Statement

Cardinal Glass is a residential glass manufacturer for doors and windows. Cardinal glass was first founded in 1962 by a man named M.L. Gordon. Today, they employ 6,000 employees across 37 manufacturing plants throughout the United States. The Greenfield, Iowa, plant distributes to local large window manufacturers. Cardinal Glass is separated into five divisions. They are as followed:

- FG- Float & High Volume Tempered Glass
- CT- Custom Tempered Glass
- LG- Laminated Glass
- CG- coated glass and optical mirrors
- IG- Insulating Glass

- The Client is experiencing problems with silicone curing in applicator tips due to lack of a better process.
- The silicone cured tips are causing re-work that is costing the company thousands of dollars in labor.

Business Case Statement

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- A. What's wrong: The tip cleaning process is ineffective. The current process has the potential for safety hazards which include the tip slipping on the bench grinder. This could result in lacerations to the arm and hands.
- B. How much is the problem costing every year: It is costing Cardinal Glass approximately \$123,000 a year in labor for cleaning the tips.
- C. Where and how often is this problem occurring: This problem is occurring frequently on all 7 lines as well as on all 3 shifts.
- D. Why is this a problem: Employees are losing production time due to the re-work of cleaning the applicator tip. This is also having a negative effect on their quality standards. Quality is affected because tips are getting clogged.
- E. Who is affected by this problem: Production personnel are having to repeat the cleaning process which is costing the company an estimated \$45,000 in additional labor expenses.

2 GOAL STATEMENT

- A. The root cause of the problem was identified to be the curing of silicone on and inside of the tips.
- B. The process will be measured by conducting a time study on the pre and post process adjustments. In order to collect data from the effectiveness of the solvents, we will use a scale to measure how much silicone was removed by each solvent.
 - o The specific parameters measured were the time it takes to clean a tip, the weights of silicone leftover after cleaning, making observations on the quality of fluid after 5 runs, and the odor of the solvent.
 - o Mann-200, MSDS A (2015), could provide a reduced tip cleaning time of 50% from 8 minutes, down to 4 minutes. The solvent was able to clean the same amount of silicone in 4 minutes. The silicone could not adhere to the surface of the tip and it was able to be peeled off. This removed the safety risk of using a bench grinder to remove the silicone. It was also calculated that it would only cost \$0.30 per tip to coat it with the Mann-200. This, combined with the newly calculated labor cost would save Cardinal Glass an estimated \$59,000 per year in labor alone. With the removal of the grinders and brass wire wheels, a potential savings of \$63,000 per year can be achieved.
 - o Some harder to measure data is safety related injuries. Cardinal Glass believes in keeping its employees safe as its number one priority. The removal of the bench grinders will allow Cardinal Glass to reduce the risks associated with bench grinder injuries and the financial costs associated with those.
 - o To implement the outcomes from this project, Cardinal Glass's lab will have to approve the use of Mann-200 on their tips and ensure it will not affect the silicone properties. Tools that were researched and other methods for making the tips easier to clean will also be introduced and left for Cardinal Glass to consider in the future. Once this is determined, a system can be made so that tips are coated at the end of each shift and a standard work for cleaning the tips can be made.
- **Main Objective(s) and Specific Objectives**
 - o **The main objective is to:** Reduce the applicator tip cleaning time by 50%. **Specific objectives include:** Removing the bench grinder and finding better tools to use. Another main objective is to determine the most effective solvent.
 - o (1) Reduce the applicator tip cleaning time by 50%
 - Must be a safe process
 - Must meet a target time of 4 minutes
 - Must be non-destructive as the tip has precision tolerances
 - Cannot use products that are environmentally harmful or pose a risk to the operator
 - Must use a product that is not aerosol based
 - Must use tools that will not damage the tip
 - o (2) Remove the bench grinder from the process

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- Must take the same or less time than the bench grinder to clean the applicator tip
 - Must be safer
 - Cannot be abrasive
- **Rationale**
 - The client will be able to save money on the time it takes to clean tips and use this money elsewhere in the plant
 - Example 1 – A 50% reduction in costs results in \$59,000 of extra funds
 - Example 2 – Removing the bench grinder reduces the risk of OSHA fines and potential injuries

3 PROJECT PLAN/OUTLINE

A. Methods/Approach

- **Reference Materials**
 - References for this project were found online, as well the use of first-person sources within Cardinal Glass such as Safety-Kleen, DuPont, Mann Release Technologies, Crystal-Clean, Natural Soy Graffiti Remover (Becker, et. Al., 2017)
 - Other sources include MSDS sheets from the solvents used, as well as MSDS sheets from the surface coatings used in the process
 - Solvents tested: Safety-Kleen, Crystal-Clean, D-limonene
 - Surface coatings tested: Mann 200, Dupont Chain-Saver, Dupont Non-Stick, Rain-X (see
- **Data collection:**
 - The data for this project will be standard time in minutes, the weight of silicone in ounces, and observations made during the experiment
- **Skills:**
 - To understand the problem, a 4-step problem-solving analysis was conducted
 - Important classes for this project include: Accounting, TSM 340, TSM 240, TSM 337, and TSM 440
- **Solutions:**
 - The solution was developed through brainstorming ideas in meetings and testing in the lab (Becker, et. al., 2017)
 - The solutions were measured by recording how much silicone was removed by each solvent and by how long it took for the tip to be clean
 - The metrics will be measured using a standard time study and a ROI schedule
 - The metrics were developed by considering the goals of Cardinal Glass along with the results that the project obtained
 - The solution was developed by finding the ROI schedule and calculating the estimated savings from the new standard time
 - The differences were quantified by time reduced and money saved
 - The proposed solution is directly contributing to the proposed objective in reducing the cleaning time by 50%
 - Proposed solutions were within the scope and deadlines for the project
 - The proposed solutions met client expectations as they were more than excited to begin investigating and implementing the new method into their company
- **Organization:**
 - The team usually met twice a week over the course of the semester, for about two hours per day
 - A report template was utilized to assign about two hours of work to each person per week
 - Major milestones for this project were:
 - Conducting research (Mann Release Technologies), (Rain-X Original), (Dupont Non-Stick), (Dupont Chain-Saver), (Msdigital.com)
 - Creating the test fixture and experiment for the project

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- Analyzing and calculating data for the client
- Some unexpected challenges were communication delays, direction changes due to EH&S, and time constraints

B. Results/Deliverables

- We want to reduce the overall tip cleaning time by 50% to reduce costs associated with cleaning the tip. We also want to remove the safety risk that the bench grinder poses to the operator by finding tools that allow the easy removal of silicone without risking their safety (Becker, et. al., 2017)
- The project was completed on time thanks to the project report template and Gantt chart
- Our recommendations for Cardinal Glass is to:
 - Use Mann-200 to coat the tips at the end of each shift which allow the tips to be cleaned easily
 - Use the provided tools to clean any residual silicone inside the tips
 - Revise and implement a standard work for cleaning the tips so that the process is repeatable
 - Research and contact the tip manufacturer on ways to smooth the casting marks inside the tip to improve both flow characteristics and ease of cleaning
 - We also would recommend adding pipe cleaning brushes (See section 8 for photos)
- The next steps to take are to:
 - Have the lab research if there are any effects on silicone quality due to the Mann-200 coating
 - If approved, implement a control method for applying Mann-200 to the tips
 - Standardize the process so that each operator performs the process the same
 - Investigate a long-term solution for a nonstick coating such as bake-on Teflon

C. Timeline

- A. Reduce overall cleaning time: 5/1/2018
- B. Remove bench grinder: 5/20/2018

4 BROADER OPPORTUNITY STATEMENT

- A. This project was conducted under the circumstances that the reader will have general knowledge and background in technology and systems applications.
- B. This project provides an opportunity for Cardinal Glass to spend the savings on new employees or possibly in the expansion of its facility in order to meet growing demands.
- C. The reason this project was important is because Cardinal Glass has other plants which see similar problems. Being able to use the coating will allow the company to save money and use those savings towards other areas within the company.
- D. Other industries that could use this include: Automotive, window, door, textiles, sealants and chemical companies.
- E. Currently, Cardinal Glass has identified this project as being an important issue and potential money saver. Because of this, Cardinal Glass did not specify a set amount for a budget of this project.

5 PROJECT SCOPE

- A. The scope of this project was to reduce tip cleaning time by 50%. There was some scope creep, which included redesigning the tip, 5S the workstation, and finding a better method for holding onto the tip.
- B. The engineering department, operators, quality department, along with safety was involved in the project
- C. Upper management, financial, and sales were not included in the scope of this project

6 GRAPHICAL ABSTRACT



Clean Tip



Dirty Tip

7 REFERENCES

Cole Becker, Andrew Eden, Brandon Hamerlinck, John Parker, Joseph R. Vanstrom, and Jacek A. Koziel. Natural Soy Graffiti Remover. Final Report. TSM 416 Technology Capstone Project, April 28, 2017.

MSDS

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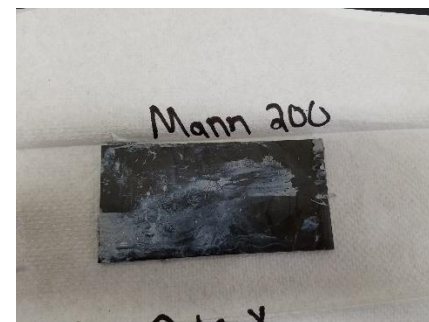
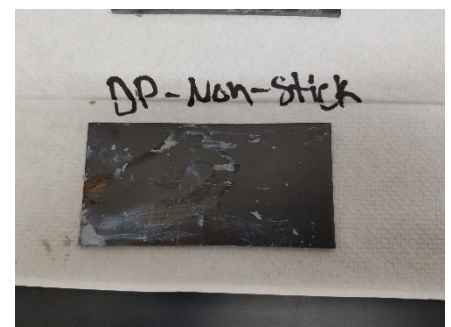
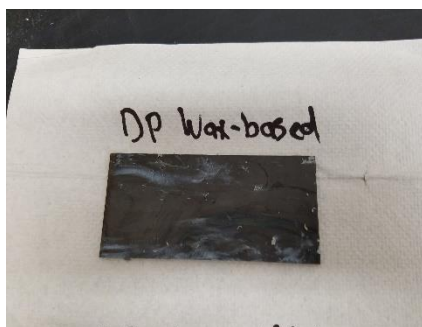
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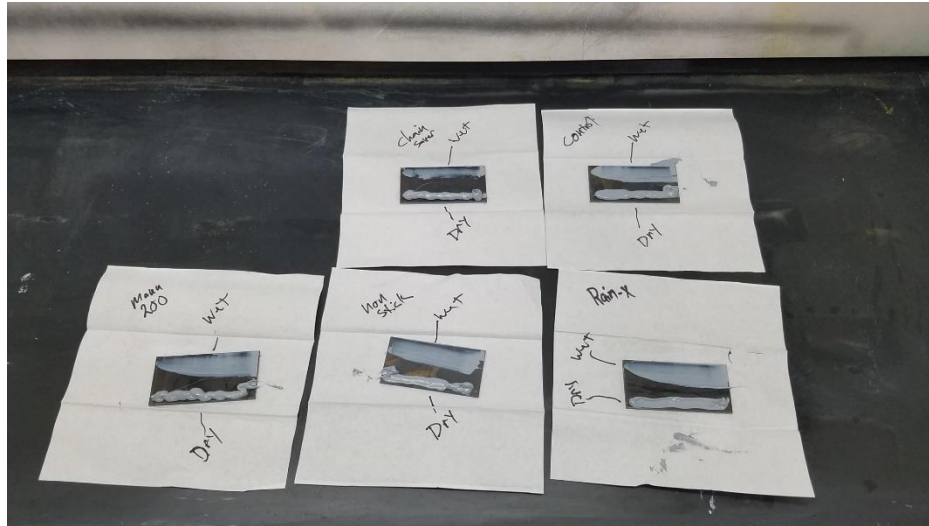
8 APPENDIXES

Include any pertinent documents that your client will need to understand your deliverables. (i.e. mechanical drawings/prints, quotes from vendors, flowcharts documenting your processes, etc.) No page limit to this section.

Pictures of surface coating test results



Spring 2018 TSM 416 Technology Capstone Project - Final Report – April 20, 2018



Team Glue Tip Cleaning Project									
Cardinal Glass Tool Cost									
Part	Cost/year								
Consums	\$600								
Solvents	\$480								
Tooling	\$300								
Total	\$1,380								

Total Annual Cost (Before)	\$113,904.00
Total Annual Cost (After)	\$68,285.16

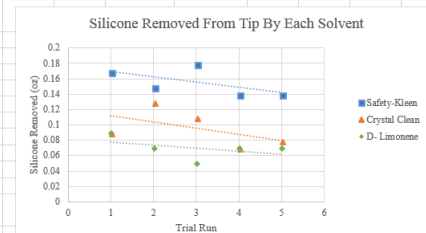
Potential Savings per year	\$45,618.84
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Team Glue Tip Cleaning Project									
Estimated Labor Costs									
Time (min)	# of tools cleaned per day per line	# of Shifts per Day	Labor rate (\$/hr)						
8	9	2	17						
Total Annual Cost/Line (Labor)				Total Annual Cost per Station (With Tools)		\$16,272.00			

Team Glue Tip Cleaning Project									
Estimated Labor Costs									
Time (min)	# of tools cleaned per day per line	# of Shifts per Day	Labor rate (\$/hr)	Amount of Mann per Tip (oz)	Size of Container (lbs)	Cost per Container	Time to apply (min)	Number of Lines	
4	9	2	17	0.33	30.1	205.99	0.33	7	
Total Annual Cost/Line (Labor)				Total Annual Cost/Line (Mann)		\$927.34		Total Annual Cost/Line (Overall)	
								\$9,755.02	

Solvent Name: Safety-Kleen			
Trial	Weight Before (Oz)	Weight After (Oz)	Description of Silicone Leftover
1	11.11	10.94	0.17
2	11.1	10.95	0.15
3	11.13	10.95	0.18
4	11.09	10.95	0.14
5	11.09	10.95	0.14
Average			0.156
Range of Data			0.04
Notes: Works well but strong odor			

Solvent Name: Crystal Clean			
Trial	Weight Before (Oz)	Weight After (Oz)	Description of Silicone Leftover
1	11.06	10.97	0.09
2	11.09	10.96	0.13
3	11.07	10.96	0.11
4	11.04	10.97	0.07
5	11.06	10.98	0.08
Average			0.096
Range of Data			0.06
Notes: Gets foamy higher solubility			



Solvent Name: D-Limonene			
Trial	Weight Before (Oz)	Weight After (Oz)	Description of Silicone Leftover
1	11.08	10.99	0.09
2	11.07	11.00	0.07
3	11.05	11.00	0.05
4	11.07	11.00	0.07
5	11.07	11.00	0.07
Average			0.07
Range of Data			0.04
Notes: Strong odor			

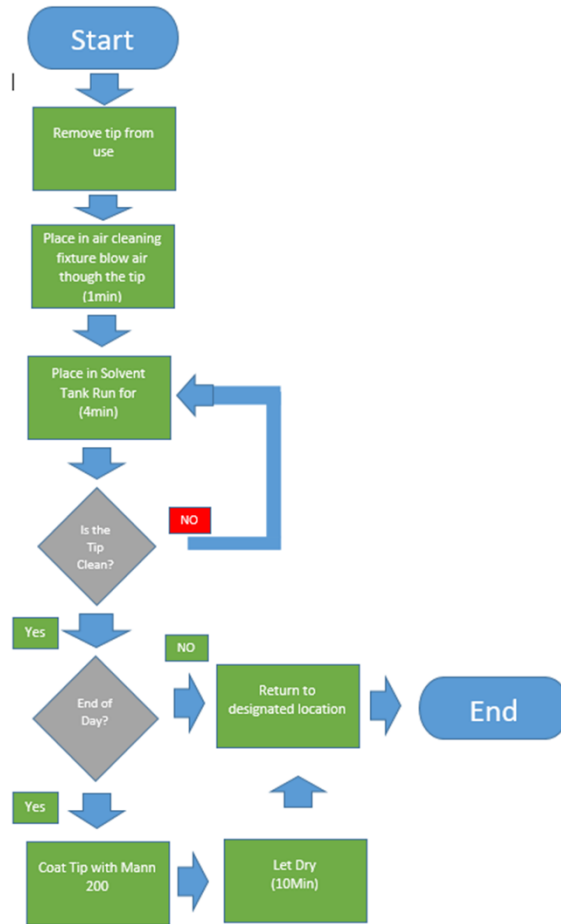
Solvent Name: Mann 200-1 min			
Trial	Weight Before (Oz)	Weight After (Oz)	Description of Silicone Leftover
1	11.03	10.97	0.06
2	11.05	10.98	0.07
3	11.05	10.98	0.07
4	11.05	10.98	0.07
5	11.06	10.97	0.09
Average			0.072
Range of Data			0.03



Solvent Name: Mann 200-4 min			
Trial	Weight Before (Oz)	Weight After (Oz)	Description of Silicone Leftover
1	11.07	10.97	0.1
2	11.05	10.97	0.08
3	11.04	10.97	0.07
4	11.05	10.97	0.08
5	11.04	10.97	0.07
Average			0.08
Range of Data			0.03

Solvent Name: Mann 200-1 min			
Trial	Weight Before (Oz)	Weight After (Oz)	Description of Silicone Leftover
1	11.03	10.97	0.06
2	11.05	10.98	0.07
3	11.05	10.98	0.07
4	11.05	10.98	0.07
5	11.06	10.97	0.09
Average			0.072
Range of Data			0.03

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Pipe Cleaning Brushes

