DEVILBISS
AUTOMOTIVE REFINISHING

Intrinsically Safe Paint Drying Device

MICHIGAN STATE UNIVERSITY

Problem

DeVilbiss is a sub-business of Illinois Tool Works Inc. that specializes in automotive refinishing products, such as spray guns, pressure cups and tanks, air control systems, and safety equipment. Recently, regulatory agencies in Canada and California passed guidelines limiting the amount of volatile organic compounds that basecoat paints used in automotive refinishing can contain.

Water is the primary solvent, which requires additional drying time. To speed up the drying process. The current design of these paint-drying guns, however, consumes too much compressed air and strips this power source from the rest of the shop tools.

A new design must be explored that will provide at least the same amount of airflow at the same velocity, while using a minimum of 50% less compressed air than the current design.

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Approach

1. Brainstorm

- Battery Power: if chosen, must operate continuously for 1 hour before recharging.
- Compressed Air: if chosen, must reduce 50% of consumption.
- Fan Blades: different designs and materials were considered to provide the best efficiency.

2. Analysis

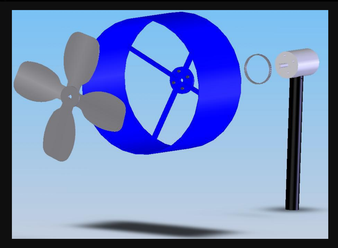
- Velocity Profile: Fluid Dynamics Lab utilized to understand the profile and its behavior.
- Air Flow: used Bernoulli's principle to calculate the airflow velocity. Used other theoretic equations to determine energy efficiencies.

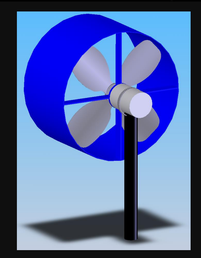
3. Test

- Air Motors: one air motor was tested but did not match the DMG-501 airflow.
- Electric Motors : two different permanent magnet DC motors were tested and provided the highest efficiency of all.

4. Prototype

- The prototype provided a flow in which the maximum velocities formed a ring pattern around the center of the 2' x 2' area.
- A final prototype was designed, tested, modeled, and assembled.

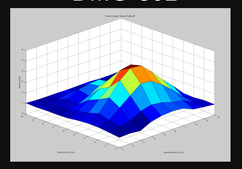


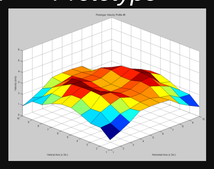


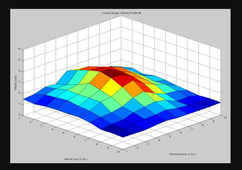
Results

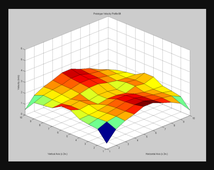
- The DMG-501 air gun produced a centrally focused flow with high velocities focused in the center of the sample 2' x 2' area. These velocities quickly tapered off to velocities of 1 m/s near the perimeter of the sample area.
- The prototype's peak velocities occurred at 3.2 m/s. The flow, however, was more spread out. Velocities at the perimeter of the sample area only tapered off to 2 m/s on average.
- Average flow velocity for the prototype was greater than the current design at 4 feet and comparable at 6 feet. This resulted in a sufficient volume flow rate of the prototype to be a successful competitor to the current design.
- Operation time: The prototype operates continuously for two hours without any significant voltage drop.

DMG-501 *vs.* *Prototype*









Velocities (m/s)

		DMG-501	Prototype
Avg. Vel.	4 ft.	1.85	2.45
	6 ft.	1.91	1.87
Max. Vel.	4 ft.	5.08	3.21
	6 ft.	3.66	2.52

Volume Flow (CFM)

	DMG-501	Prototype
4 ft.	1012	1337
6 ft.	1045	1025

Recommendations

- Battery powered design alternative has great potential for automotive repair shops that lack the capability to support compressed air powered guns.
- They show the capability to produce sufficient air streams.
- Power from small batteries have the potential to drive these devices for long periods of time before recharging.
- They are relatively more compact than compressed air guns and have lower noise levels.
- Further analysis can be researched into compact electric drive motors to reduce packaging and fans blades that will consume less power while providing ample air flow.