Appx. 18 million bicycles, valued at over US$6 billion, are sold in the North America annually. *99% of those bicycles are imported.*

That is appx. 180,000 produced in the US every year. We’ll be looking at the impact painting of those bicycle frames has on you, the economy and the environment.

Do you own a bicycle? Do you like riding your bicycle? Do think you need (or maybe want) a new bicycle soon? How would you like to pay less for the bicycle? What if changing the paint process would make the bicycle less expensive and have less impact on the environment?

Paint is expensive = increases cost of bicycle

Labor to paint is expensive = increases cost of bicycle

Paint is solvent based (VOC) = additives evaporate into the air

(VOC = Volatile Organic Compounds) – VOCs contribute to short- and long-term adverse health effects, however, solvent based paint create the most durable and highest quality finish.

The majority of painting in the bicycle industry is done by hand, or in a semi-automatic process. A very small percentage of bicycles are painted by robots.

*Video of bicycles being painted by hand (lots of overspray) -* [*https://www.youtube.com/watch?v=jk9G8Krkqd4*](https://www.youtube.com/watch?v=jk9G8Krkqd4)

You might ask, why don’t we look at automobiles? They must use a lot more paint. – That is true, but almost all vehicles are painted by robots and the automotive industry uses primarily water-based paint. Water based paint does not release the VOC upon drying.

You are encouraged to do your own measurements on an actual frame. If that is not available, we provided a 1/10th scale template that students can measure and use for calculation.

Here is some information you might need later (we simplified and averaged some numbers):

* Average paint thickness on a bicycle frame (4 layers, each 0.005” thick) = 0.020”
* Average tubing diameter on a bicycle = 1.25”
* Average accumulated length of tubing on a frame = 178”
* Average wheel diameter = 26”
* Average rim width (paintable) = 1.5”
* 1 gallon of paint weighs appx. 10lbs
* 1 gallon = 231 cubic inch
* Avg cost for 1 gallon of paint = $25
* Paint to solvent ratio = 2pt paint : 1pt solvent

Let’s do some math. Based on the information above, answer the following questions:

1. What is the total surface area of the bike frame that you need to paint?
2. What is total surface area of the two (2) rims (remember, there are two sides to a wheel)?
3. What is the volume of paint you have to use, for both the frame and the two rims?
4. How much does the total volume of paint weigh?

Did you imagine, that the average weight of paint on a bicycle is almost 1lbs?

This can vary a lot by the size, type and construction of a bicycle. The above is just a simplified average.

Something else that has to be considered for any painting process, is the amount of overspray. A manual, or semi-automatic paint process waste about 50% of the paint. Considering 50% more paint, what is the total amount of paint used?

*Did you know? Racing bicycles often, have less, or no paint finish, give racers a competitive advantage.*

* Based on industry experts, a robotic painting process is roughly 75% efficient
	+ How much money could be saved per bicycle (avg cost for 1lbs of paint = $25)?
	+ How much paint (in lbs) can be saved if all bicycles in the US would be painted by a robot?
	+ How much money could be saved (and passed on to the consumer), if all bicycles produced worldwide would be painted by a robot?

Objective:

Plan and create a painting process, which reduces the amount of overspray, resulting in lower cost and less environmental impact.

Requirements:

* Precision and accuracy is most important.
* To achieve optimal coverage, you can’t exceed 200mm/sec
* Maintain the paint spray width centered on the frame (tubing) and rims
* Do not paint any tube twice within one cycle
* Do not idle, stop anywhere on the frame or rim
* One Main program that sets all parameters (Override, UF, UT)
* Three subroutines: One to paint rims, one to paint frame, & one to purge paint from gun
* Teach one Tool Frame
* Teach one User Frame
* Use appropriate motion types for painting, move to Home, move to Purge and when not painting

Optional:

1. Use two “paint guns” in different colors (one for rim & one for frame)
2. Print bike frame in 3D
3. Print bike frame in 2D (outline)
4. Mount bicycle vertical and paint from both sides
5. Set up two bikes and “paint” using User Frame and PR points
6. Detect (one or multiple) bike frame(s) with vision camera and paint
7. Use a light that is on, when painting (controlling Digital I/O)
8. Index or flip the frame to paint the opposite side
9. Use iRvision to locate major, unique components and do Linear moves between them

Basic robot program:

1. Main program is called
2. Bike is “conveyed” in or placed in workzone
3. Laser “painter” is staged in fixture
4. EOAT picks “paint gun”
5. Robot moves along frame lines, paints entire frame and rims
6. “Paint gun” turns off between frame segments, wheels and purging cycle
7. Laser “painter” is placed back in fixture