SAMSUNG

INSPIRATIONAL CASES | WINNER 2023 | COLOMBIA

#HEALTH

Students create ink from vehicle smoke

The students managed to combat air pollution with programming, artisanal assembly and simple materials.

TEACHER
Jhon Alexander Echeverri

STUDENTS
Emmanuel Medina Quiceno
Jalyn García Castaño
María José Bolívar e Sherly Jislem Gómez Martínez

COMMUNITY/CITY
Envigado

SCHOOL
Institución Educativa Comercial de Envigado

PROJECT NAME
Máquina Transformadora de Humo Vehicular a Tinta (Transformer Machine of Vehicular Smoke to Ink)

STEM AREAS
Science, Technology and Mathematics

OTHER AREAS OF KNOWLEDGE
Art and Environmental Education

A student from Envigado once said that, when he felt the smoke from a car on his face, it was as if black ink covered his skin. From this anecdote a student project emerged, which decided to transform air polluting factors into usefulness for the population. The project was titled as “Máquina Transformadora de Humo Vehicular a Tinta” (Transformer Machine of Vehicular Smoke to Ink, in English). It was developed by a group of students and was established as one of the five winning initiatives of Solve for Tomorrow Colombia, in 2023.

Around 30 students from the 10th grade, the second to last of compulsory schooling, were involved and represented by a team of four outstanding students, aged 15 and 16. When they had to decide what challenge they should focus on to apply for Solve for Tomorrow, they chose air pollution, as it is a frequent issue in the country and it directly impacts their lives. Sometimes teenagers can’t even do sports outdoors, due to high pollution. In 2015 alone, poor air quality caused around 10,000 deaths in the country, according to the National Planning Department.

The mediator teacher was Alexander Echeverri, who in 2023 taught Physics and Chemistry. This year is responsible for the extracurricular subject of the Integrated Areas Project. He remembers that the first step was to research the topic, with the help of the school librarian. The students spoke with family members and neighbors to hear their stories about how they are impacted by

air pollution. Then they did an interview with the city's Environment Secretariat to find out what was being done to combat the problem. "Basically they told them that the measures are to do the vehicle rotation system [known in Colombia as "pico y placa"] and advise people to stay at home when the air quality is very bad. That solution seemed insufficient to them and they looked for a more technological alternative," he said.

After searching different sources, they found a way to generate filters to absorb carbon dioxide and transform it into an ink to obtain pitch (or tar), which is used as asphalt to pave the streets. But the students thought about diluting that ink and using it for other purposes.

To make the prototype, they used a fan that was no longer working well. They took it apart and programmed it so that instead of the blades emanating air, it absorbed it. The machine then absorbs the carbon dioxide from the vehicle's engine. The soot that remains at the end is mixed with methanol and caustic soda to create a condensed ink that can be diluted and used for various purposes, such as refilling a school marker.

Eureka Moment!

A fan normally depends on energy to emit air as well as to absorb it. The first prototype attempt was very small and only powered by a battery, but its size was insufficient for larger vehicles. Later, they manufactured a larger model, but it discharged after a few hours of use. It would have been unsustainable to use standard batteries and impractical to plug it in (since the device was connected to the vehicle's engine). With many attempts and more searches, they finally came up with the idea of using renewable energy in the device and thus solved the limitation.

"They learned to measure frustration and be resilient. Error should not be a demotivating factor, rather an incentive to grow",

highlights Alexander Echeverri.

The solar panel was made of polycrystalline silicon with a capacity of 5V and 60 mA, and located at the top of the prototype. "It was an evolution. The first ones worked for vehicles where the muffler was smaller and then they tested on motorcycles, where it was larger. Then they had to expand the size of the filter while doing the tests," says the teacher.

Many trials were also necessary to make the ink: “The amount of soot mixed with the amount of methane was not enough: either the ink was very transparent or permanent. After many attempts we managed to make the ideal combination,” adds the educator.

The device uses a fan that is no longer working and a solar panel was placed on top of the prototype.

Alliances were essential for testing

When they reached the prototype validation stage, the alliance with an automotive workshop located in front of the school was of great importance. Until that point, people did not feel safe making their vehicles available to test the new device, and the owner of the workshop was the first to bet on the idea. “The group went directly there; they spoke with the owner and he made the engines available for testing. Then he began to reach out to other people to get them involved as well,” he reports.

Thus, the team carried out the testing in taxis, private vehicles and even buses. In general, the conclusion was that the larger the vehicle, the more soot was generated and the more inks were extracted. But changes also emerged, according to the vehicle models and types of fuel used, among other variables.

A medium-sized car, with two or three hours of driving, can generate approximately one liter of ink. That is: 40 or 50 grams of soot mixed with 500 ml of methanol and four grams of caustic soda.

From the air to the ground of the street

The ink was already used at the school to make markers for teachers. Now, in 11th grade, students

continue testing new tools for creation. “Thanks to Solve for Tomorrow mentoring, students are already transforming smoke not only into ink but also into tar,” says Echeverri.

The alliances have continued after the program and the award gave a lot of visibility to the initiative. Even the public administration showed interest in sponsoring the project to do it on a large scale. “They had a recognition that opened many doors: the mayor gave them a certificate and promised to promote and sponsor the project so that they could continue,” proudly says the educator. He also hopes that scholarships can be arranged from the Mayor’s Office so that students can continue their projects at the University next year.

Motivation to continue

For the teacher, his role as mediator is to motivate students and find resources so that they can carry out the project. “For example, what I had to do was provide them with the space, get them the computer so they could be in the program talk, guarantee the 3D printer and give them programming tools. Well, the students are the ones in charge of ensuring that these means become reality.”

As a result of participating in calls such as Solve for Tomorrow, Echeverri notes that the school began working with project-based learning approximately three years ago. “For Solve for Tomorrow in 2023 we applied for almost 50 proposals, of which three projects advanced to the semi-final and two were among the five winners. It was a very important recognition for us,” he declares.

“The projects have made students in this school have more desire to study. They do not learn just for the grade, but to be able to apply learning in the context of daily life, which I believe is the meaning of education,” he concludes.

SAMSUNG

Explaining!

In addition to the damage to the population's health, the environmental costs associated with air pollution in Colombia reached 15.4 billion pesos (approximately 3.8 billion dollars), according to the National Planning Department. The pollutant with the greatest potential to affect the country is Fine particulate matter at 2.5 microns (PM2.5), coming mainly from heavy vehicles that use diesel as fuel.

Focus on practice!

Take a look at the teacher's guide on how to create a machine that transforms vehicular smoke into ink.

1 Empathy

The decision to work on air pollution was based on alarming data from Colombia: in 2015 alone, poor air quality caused around 10,000 deaths, according to the National Planning Department. In addition, the students themselves had experiences that drew their attention to the topic. When a car blew engine smoke into the face of a student, he commented that it was as if he had black ink on his skin and that's when the idea of the prototype began to emerge.

2 Definition

The team investigated this matter, with the help of the school librarian. The students spoke with family and neighbors to learn how they are impacted by air pollution. Then they did an interview with the city's Environment Secretariat to find out what was being done to combat the problem.

SAMSUNG

Ideation

The team did not consider as sufficient the existing solutions and wanted to go further. It was not enough to decontaminate the air and filter carbon dioxide emissions from vehicles. They wanted to turn the smoke into something useful and found a way to transform it into an ink to generate pitch (or tar), which is used as asphalt to pave the streets. They decided to dilute it and use it for other purposes.

Prototype

They used a malfunctioning fan, took it apart, and programmed it so that the blades sucked in air instead of releasing it. Then, with the 3D printer they made the bases of the prototype to be able to embed the fan. Next, they bought filter paper to extract the carbon dioxide and tweezers to attach the device to vehicles. Additionally, the team had a carbon dioxide meter to look at the concentration of the pollutant in the air.

Testing

To validate the prototype, they made an alliance with an automotive workshop located in front of the school. The team carried out the testing in taxis, private vehicles and even buses. Tests showed that a medium-sized car, with two or three hours of driving, can generate approximately one liter of ink. That is: 40 or 50 grams of soot mixed with 500 ml of methanol and four grams of caustic soda. But there are also changes according to vehicle models, fuel types, among other variables.