

# DOUBLE EXPOSURE

Media darlings by night, engineering nerds by day. These guys uncovered the Volkswagen emissions cheating scandal. You want them in your corner.

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**WVU researchers uncovered an emissions cheating scandal that made headlines around the world, but the real story is how their work will create safer, healthier cities.**

Four men emerged from the lab, rapidly blinking as their eyes adjusted to the sunlight. They walked straight ahead, expressionless and unsmiling. Fanning out, they hit their marks as a camera jib floated down to meet them at eye level. Staring straight down the barrel, they stood motionless until a voice from behind the camera yelled, “Cut!” They looked at each other and burst into laughter.

The television crew from *60 Minutes Australia* was top notch, efficient and organized, professional and quick. One of countless media outlets from around the world that descended on West Virginia University’s campus, they sought to tell a “David versus Goliath” story— pitting a small laboratory at WVU against the No. 1 car maker in the world.

But for WVU’s researchers there was always more to the story.





For Dan Carder, a self-proclaimed engineering nerd from Parkersburg, W.Va., the media circus that has surrounded the work of WVU's Center for Alternative Fuels, Engines and Emissions, or CAFEE, over the past seven-plus months has been entirely surreal.

"When I became an engineer 25 years ago, I never thought the general public would be interested in this kind of research," said Carder, who has been director of the center since 2010. "I certainly never thought I'd get a phone call from Leonardo DiCaprio's 'people,'" he said in reference to the actor's intent to produce a feature film about the U.S. Environmental Protection Agency's discovery that Volkswagen had been cheating on emissions tests.

"We're probably the last people you would want as spokespeople," he laughs. "We spend most of our time in the lab or in the field working on equipment or analyzing data."

But he and the rest of the five-person team whose research on real-world diesel emissions revealed data that broke open the Volkswagen scandal have taken the attention in stride — even though their newfound media responsibilities have usurped more quality lab hours than they would prefer.

Their unceasing dedication to their work was apparent two-and-a-half years ago when Marc Besch, Arvind Thiruvengadam and Hemanth Kappanna — all graduate students at the time — alternated 16-hour shifts to drive three test vehicles around southern California and up to Seattle.

In 2013, CAFEE contracted with the International Council on Clean Transportation, an independent research group, to conduct a small \$70,000 study on emissions levels from diesel passenger vehicles in the United States.

The council reasoned that because the U.S. had the most stringent emissions standards in the world, diesel cars in the U.S. market would have to be ultraclean. Basically, they set out to prove that if diesels could make it here they could make it anywhere.

## REVEALED ON THE ROAD

Spoiler alert: They were wrong. (Well, not entirely, but more on that later.)

After the International Council on Clean Transportation presented the results of the WVU study to the EPA and the California Air Resources Board, the regulatory agencies did some digging of their own. Eventually, Volkswagen admitted that their diesel vehicles employed a "defeat device" — complex instructions coded in the car's computer-controlled brain that turned on emissions control technologies during compliance tests in the laboratory and then turned them off during real-world driving situations. Outside of the lab, cars were spewing up to 35 times more oxides of nitrogen than allowed by regulatory standards.

When WVU began the study, government regulators only performed compliance tests in a lab setting on a chassis dynamometer — basically a treadmill for cars. They did not have compliance tests for diesel passenger vehicles out on the road, but the EPA says that will change soon.

"Car makers know exactly how they are going to be evaluated by regulators," Carder said. "It's like giving a student all the questions to a test before the student takes the test."

"The happiest moments for us aren't related to anything in the news. They are when we find out that our research has made a change."

ARVIND THIRUVENGADAM



MARC BESCH





## A CLEANER FUTURE

On the wall of screens in the WVU media control room, the CNBC video feed showed Pope Francis on his historic visit to the U.S. about to board a plane. Down the hall, Dan Carder sat in a silent studio in front of a single camera awaiting his cue. For him, the momentary pause was a welcome reprieve from the media onslaught. Carder's phone had not stopped ringing for days and his voice mailbox was full. Suddenly, a voice in his ear monitor told him that as soon as the Pope's plane left, he would be live on air. Plastered across the screen was a graphic showing that up next was "The Man Who Uncovered Volkswagen's Lie."

Reprieve over.

CAFE has grown to include nine faculty members, five engineers, five technicians and more than 30 graduate students whose research is focused on the study and development of technologies necessary to improve transportation and power systems while working toward a cleaner environment.

They built the largest national database of heavy-duty vehicle exhaust emissions and fuel efficiency data, which is used by the U.S. Department of Energy, the U.S. Department of Transportation and the EPA for air-quality control.

The center pioneered efforts in measuring real-world emissions from mobile sources with PEMS, and now they are ready to introduce a new device that will provide a bridge between real-world vehicle emissions data and health.

AirCom, a device about the size of a large television remote, is a miniature version of PEMS equipment (it's referred to as micro-PEMS). It is small enough to install on a vehicle's tailpipe.

Lightweight and inexpensive — with an anticipated cost of a few hundred dollars — compared to the \$250,000 price tag of PEMS equipment, AirComs can be installed on a fleet of vehicles.

"You're looking at the potential to gather a huge amount of incredibly valuable data," Carder said. "You'll be able to see concentrations of pollutants in real time, and then be able to make decisions about when and where to drive based on that information."

Think crowdsourcing for the environmental circuit.

Last year, the White House announced its commitment to the development of "Smart Cities" to help communities

build infrastructure to continuously improve the collection, aggregation and use of data to improve the lives of their residents.

AirCom will be a step forward in gathering and spreading out emissions data. The more data they are able to collect, the better air-quality modelers can predict concentrations of air pollution.

"This is an area where we know we can make a difference," Carder said. "By gathering and connecting this data, we can help cities and the people who live in them. That goes beyond the U.S., too. It's work that can be applied to global population centers like China and India."

Soon after news broke of the Volkswagen scandal, media outlets were quick to position, Dan Carder, Greg Thompson, Arvind Thiruvengadam, Marc Besch and Hemanth Kappanna as heroes, champions of the people, who took down a corporate giant. But in many ways — actually, most ways — they are typical engineers who aim to make an impact on people's lives with their research. Their lives and work are interdependent — there is no distinction between the two.

In January at the North American International Auto Show in Detroit to collect the "Disruptors of the Year" Shift Award from CNET, the five-member team disappeared inside the Ford exhibit.

Never mind the fact that they were being recognized on the biggest stage in the automotive industry. They were like kids in the shiniest, and most expensive, candy store in the world.

With boyish enthusiasm, the most talked-about engineers in the industry bounced from exhibit to exhibit, admiring engine configurations and technology systems.

"So pretty," one whispered while fawning over a brake display.

The fraternity among them was unchanged, evidenced by the ceaseless brotherly banter.

Will they ever stop teasing Besch about how long it has taken him to finish his dissertation? Probably not until they've seen him through graduation.

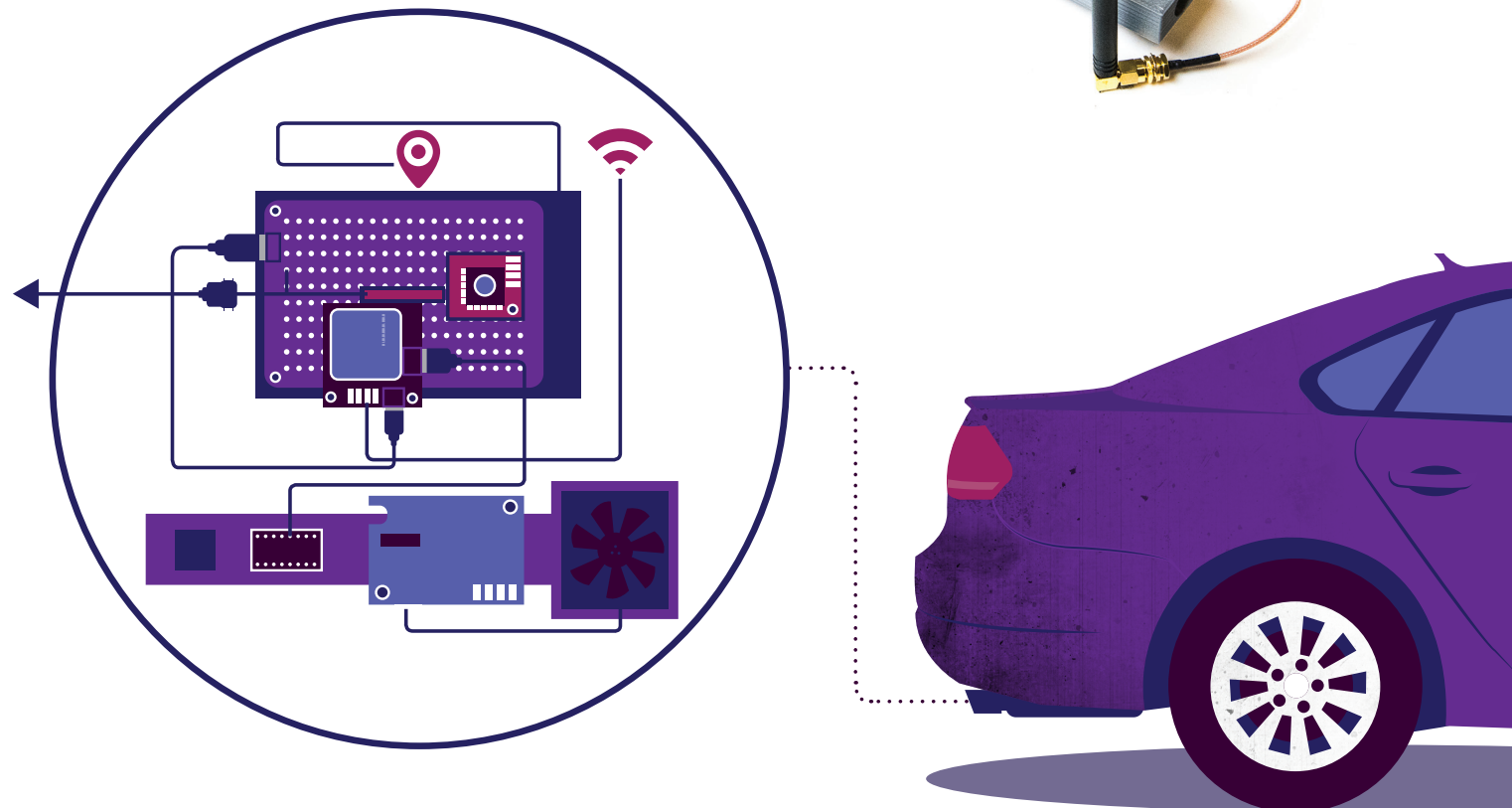
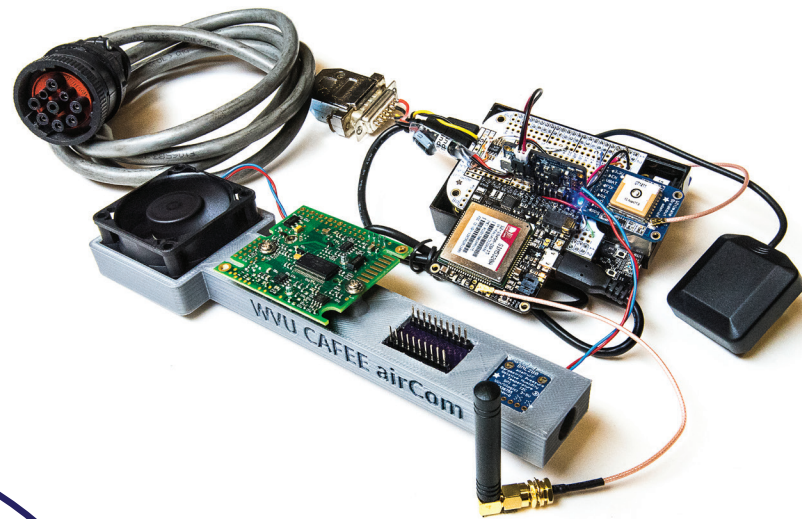
In the meantime, they will continue doing what they've done for decades — moving technology, emissions research and the industry forward — long after the show lights have dimmed and the glare of the media lens has faded. ♡

"I was working in the lab when the news broke... the first phone call I answered was a reporter and she told me I should really check the news. That was when I knew something big was happening." DAN CARDER

# HOW'S THE AIR OUT THERE?

You're inhaling air reading this right now. And when you're walking your regular route on your town's streets, you could be breathing in pollution from emissions. It would be great if there were something that could be fitted on many cars at the same time to track concentrations of air pollutants. With AirCom, that will be an everyday deal, and it comes to us from the WVU team who discovered Volkswagen's cheating of emissions standards. Research at the **Center for Alternative Fuels, Engines and Emissions** led to the commercial development of portable emissions measurement systems. Now the team has created a micro-sized version of the device called AirCom, the size of a large TV remote, which can connect to a car's tailpipe and has a projected cost of a few hundred dollars. So when cities look to reduce air pollution, they'll have AirCom on their side.

► **AirCom** is small enough to attach to a car's tailpipe and is equipped with GPS, WiFi, a power system and battery. The adaptable components can record location, vehicle and engine measurements and readings from environmental sensors. The sensors are where the important work happens. And it all happens in real-time, relaying information live to a website using the cellular network.



# THE NEXT BIG THING BEGINS HERE.

West Virginia University is designated a Highest Research Activity university according to the Carnegie Classification of Institutions of Higher Education. This means growing answers to your questions. Like how to make cars run cleaner. How to keep water safe. And how to make our lives better tomorrow than they were yesterday.

