

represented more than 100 person-years of work — also proved cumbersome. First, he had to ensure that every line was duplicated in Edinburgh. Then he and his lab members arranged for the cell lines and reagents to be stored properly in liquid nitrogen and packed carefully into supercooled containers. The group loaded a truck with the cell lines and reagents and then flew to Copenhagen to meet it and ensure that the biological material was still stable.

Complicating matters further, the MRC Centre for Regenerative Medicine at the University of Edinburgh, where Brickman's lab was based, was moving to a new building at the time that the stem-cell centre in Copenhagen was under construction. When he learned that the opening in Copenhagen would be delayed, Brickman felt it best to move the bulk of his lab to temporary facilities in Denmark rather than to the new building in Scotland — even though he would later have to transfer again to the permanent lab.

Managing lab members in two sites also proved challenging. Brickman had landed a collaborative UK grant before he left, so he hired a new postdoc to work at his Edinburgh lab and continued to manage three lab members who remained there. He could not directly supervise his new recruits much of the time, and so missed out on day-to-day knowledge of how his Edinburgh lab functioned; he commuted between Scotland and Denmark weekly for three months but worked mainly in Denmark over the next two years. The protracted move, he says, may have delayed the publication of papers — an unfortunate result for his junior co-authors, although he says that the papers were eventually accepted into high-impact journals.

Despite all the snags, much went right, Brickman says. He credits administrative support in both Edinburgh and Copenhagen for the smooth relocation of his lab group. "All of my people were able to move both work and personal lives," he says. "None of them ended up homeless, despite moving to a new country where they didn't speak the language and in a city where it is almost impossible to find rental apartments." In the end, clearing the many logistical hurdles proved worthwhile, he says, because the new stem-cell centre's strengths outweigh the hassles that he underwent to join it.

There is no way around it — moving lab, whether within a university or to another country, is gruelling, stressful and likely to include disaster or catastrophe. Ultimately, however, no one can plan for everything, and adaptability is perhaps the most useful resource. "I am much more unflappable now," says Godbey. "The more extreme the situation, the more flexible you need to be." ■

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## TURNING POINT

# Daniel Carder

*Daniel Carder, director of the Center for Alternative Fuels, Engines and Emissions at West Virginia University (WVU) in Morgantown, was on a team whose work led to Volkswagen's admission that some of its diesel vehicles contained software able to sidestep emissions tests.*

### What does the centre do?

We have done vehicle-emissions testing and technology development for 25 years. We designed the first mobile diesel-fuel measurement systems, which use detectable carbon emissions to determine consumption. In addition to fundamental research, we produce open data on how new automotive technologies, such as clean diesel, prove in practice. We also try to make them more efficient.

### Can you describe your research?

I have bachelor's and master's degrees in mechanical engineering from WVU, and will complete my PhD this year. I am involved with the measurement and control of emission particulates related to diesel-fuel usage. My thesis work led to the adoption of US federal standards for particulate emissions in underground mine extraction. That technology controls highway and off-highway emissions.

### Did you expect to find any problems?

Quite the contrary. In 2013, we received US\$69,000 from the International Council on Clean Transportation to test the diesel emissions of two Volkswagen models. We expected to show that clean diesel fuel was doing a good job. We had seen successful demonstrations of the same type of technology in the bus and tractor markets and wanted to translate them for passenger-vehicle manufacturers.

### What were your first experimental results?

We believed that these systems would reduce emissions from 1,000 parts per million of particulates to 10–20 p.p.m. When we saw initial data for the Volkswagen vehicles, the first thing we did was scrutinize our work. Did we make a mistake with calibration? We double- and triple-checked our data and procedures. After several quality-control exercises, we were assured that our findings were valid. But it wasn't in our contract to find out why.

### Were the data made public?

Yes. Marc Besch, also a graduate student, presented the discrepancies in 2014 at a workshop in San Diego, California, attended by people from the US Environmental Protection



Agency, petroleum companies and engine manufacturers. Before we left the conference, we were contacted by Volkswagen asking about our techniques and data-collection methods. It seemed like a normal fact-finding mission.

### When did you realize that this was a big story?

I was in the lab on 18 September when the news broke. My hands were filthy from working on diesel engines. My phone was ringing continuously, but I didn't recognize the numbers — reporters were calling. We were blindsided.

### Can you describe the media attention?

Constant. I am the poster boy for why everyone should have media training. It's been trial by fire.

### How has the discovery affected your work?

You never know when routine research could have a major impact. And it has provided a good way to talk to our students about the quality and custody of data. It is satisfying and rewarding to be recognized for work behind the scenes.

### Do you have any concerns about the fallout?

We are the data collectors who will develop and refine new technologies. One concern is the perception that our objectivity could be compromised. We have strived to get industry to work with academia on emissions-control technology and policy issues because we believe that researchers cannot sit in ivory towers.

### What should the public know about your work?

As support for earmark funding has waned for centres such as ours with a mission that benefits the nation, we have shown that they have merit. It's difficult to keep ventures like this afloat without congressional support. ■

**INTERVIEW BY VIRGINIA GEWIN**

This interview has been edited for length and clarity.