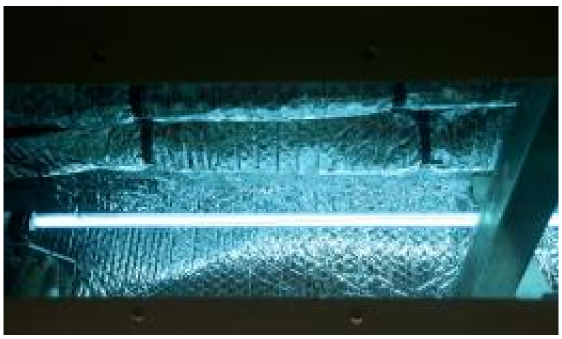
College students work to sterilize air, kill pathogens on buses

April 27 2012



High-powered ultraviolet lamps installed on a Houston bus have proven to kill nearly all of the pathogens that flow through the air conditioning system, according to a student engineering team at Rice University. (Credit: Tommy LaVergne/Rice University)

The best place to enjoy a breath of fresh air may be a city bus, if Rice University students have their way. A team of graduating seniors has created a system for public transit that would continually clear the air of pathogens that can lead to tuberculosis (TB), flu and pneumonia.

The CityBusters – Joseph Spinella, Jerry Lue, Sundeep Mandava, Grace Ching and Shidong Chen, all seniors – have installed a $500 device on a METRO bus in Houston that has proven effective at killing 99.8 percent of the pathogens that circulate through the air-filtering system. The device, called FluProof, incorporates high-powered ultraviolet lamps that sterilize the air on the fly.

Spinella said research by others has suggested that buses, being enclosed public spaces, can provide an environment for the spread of TB and other diseases. "These are closed spaces where people are in close proximity, and you have an active air-conditioning system that's continually mixing up the air and spreading it to all the passengers," he said.

The Rice project stemmed from the results of a study called the Houston Tuberculosis Initiative (HTI). Researchers worked from 1995 to 2004 to identify patterns of transmission in the region that – though the disease is still rare – has the second-largest TB population in the nation. They were surprised to find a correlation between riders of city buses and cases of tuberculosis. A study published last fall in the journal Tuberculosis put numbers to the risk by pointing out that some routes, particularly long ones, indicated a higher number of cases of the disease. The lead author of the HTI study prompted the Rice project when she decided to act on the research results. "We found we had a problem on the buses in Houston," said Marsha Feske, a former graduate student at the University of Texas Health Science Center at Houston and research fellow at The Methodist Hospital Research Institute. She is now an epidemiologist at the global biosciences company Becton Dickinson. "Knowing Rice had some expertise in tuberculosis, I contacted Maria Oden to see if the university could help."

Oden, a professor in the practice of engineering education and director of Rice's Oshman Engineering Design Kitchen, pitched the idea to students looking for capstone design projects, which are required of all senior engineering majors at Rice. Five took on the challenge.

With Feske, Oden and Rice bioengineering lecturer Matthew Wettergreen as advisers and METRO staffers offering technical help, the team came up with a streamlined system that falls well within the ability of a METRO bus to power it while surpassing even their own stringent requirements that FluProof kill 99 percent of airborne pathogens.

The CityBusters team installed a unit on a working METRO bus and demonstrated it during the annual George R. Brown School of Engineering Design Showcase, held during Rice's UnConvention open house April 12. "We have two lamps installed, one on each side," said team member Lue as he stood at the back of the bus and pointed to one of the units above the seats. The unit was visibly glowing through a transparent cover. "All the air passes through both lamps from an overhead duct. Any air that's exposed to the light will be sterilized, and any pathogens will be killed," he said. "The overall design is fairly simple, but it does what it needs to do."

"Our design has a couple of unique features," Spinella said. "We used reflective aluminum to line the inside of the ducts, which doubles the intensity of the UV lamps. We also used an air-flow sensor so that when the bus is running and air is flowing normally, we can be sure the lamps are on. When the air isn't moving, the lamps turn off for power efficiency."

Tests on the FluProof-equipped bus included both UV intensity analysis and microbial air sampling. "When we cultured the air samples gathered from our bus, we discovered zero bacterial colonies," Spinella said. "That was even less than what you would see in outside air, and much less than in a bus without our system installed."

Team members have filed for a patent on FluProof and hope to commercialize it. In the meantime, METRO will keep tabs on their progress.

"When the opportunity arose to partner with Rice University and the students, we said, 'We're on board,'" said Andrew Skabowski, senior vice president of service delivery for Houston METRO. "We've been a facilitator, more than anything. All the engineering work was done by the students, and they were excellent. They worked very hard.

"We want to do anything we can do to improve the environment within a bus for our passengers," he said. "Cost and reliability are important factors to us, but we'll take a serious look at whatever they come up with."

After local media reported on the CityBusters project last fall, the Houston Department of Health and Human Services took issue with the finding that bus routes are a risk factor for tuberculosis transmission, as detailed in the HTI study, and issued this statement: "Tuberculosis transmission has never been associated with public transportation. … Transmission of TB is most common among family members and other close associates; casual, irregular contact in a hallway or a bus is very unlikely to cause infection." The statement noted UV light from sunlight is an effective disinfectant on buses during daylight hours, and that typical public transportation has good mechanical ventilation and frequent door openings. Despite their reservations, city officials also value the work Rice students are doing.

"The Houston Department of Health and Human Services always appreciates the contributions of the academic community in preventing the transmission of communicable disease," said Kathy Barton, chief of public affairs for the department. "The CityBusters initiative is worthy of further investigation, particularly for buses used in longer commuter routes that may have less air exchange due to fewer stops and may have more darkly tinted windows, which reduce the ambient ultraviolet light. Until sick people can be convinced to stay home, there will always be a need for innovative interventions."

Provided by Rice University