New Testing Device Identifies Unseen Hazards Around The World

Bioplex Technologies
University of South Florida

David Fries has dedicated his career to developing instrumentation that helps scientists see the unseen. The results of his work are embodied in a small but powerful device called the SE 300 Portable Bioreaction Monitoring System: a handheld diagnostic device with a multitude of potential uses — from the beach to the bedside.

The SE 300 is a miniature version of a fluorometer, a standard piece of laboratory equipment that identifies and characterizes specific molecules within fluid samples. The size and portability of Fries' device — the SE 300 is the smallest handheld fluorometer on the market — allow it to move from the seashore, where it can quickly analyze water samples for bacteria and other environmental hazards, to disease testing in remote areas with minimal or no access to health care services.

Thinking Outside the Ocean

The SE 300 had an unlikely beginning — underwater.

Fries, who holds bachelor's and master's degrees in chemistry, heads the Ecosystems Technology Group at the University of South Florida (USF) College of Marine Science in St. Petersburg, Fla., which operates an assortment of underwater instruments that plumb the depths of the ocean.

"As a university on the Gulf of Mexico, we work very aggressively in that space, monitoring the health of the gulf and the safety and authenticity of our seafood," explains Valerie McDevitt, assistant vice president for patents and licensing at USF.

Fries was working on an automated underwater probe capable of detecting microscopic toxins in the ocean when he recognized another application for his aquatic device. In someone's hands, the molecular detector could do more than monitor water quality — it could also be used to obtain important measurements in the field for environmental testing and test for human diseases such as dengue fever, a tropical viral disease that has recently spread to Florida.

"David is not someone who thinks outside the box, he is oblivious that there is a box," says McDevitt. "He is constantly looking at how a technology in one field can be tweaked and applied to another field."

With the help of fellow inventors Andrew Farmer and William Flannery and funding support from the Space Missile Defense Command and the Florida Sea Grant Extension Program, Fries began building the portable fluorometer.

Building the SE 300

The SE 300 was designed to identify bacteria — or species of fish — by testing for the presence of a specific genetic code, or more specifically, a signature ribonucleic acid (RNA) sequence.

The system begins with a single test tube, which is filled with cellular material from a fluid or tissue sample and combined with a concoction of enzymes and other reagents. The tube is then inserted into the device, where an infrared heat source and two light-emitting diode (LED) sources help catalyze a biochemical reaction inside the tube.

> *"It's important to maintain the temperature with precision for the biochemical reaction to happen," explains Fries.*

Whether the fluorometer is being used to detect an RNA sequence specific to grouper fish or to dengue fever, HIV or E. coli, all tests use the same hardware and process — only the mix of chemicals added to the test tube changes.

"Each chemical assay includes molecules called primers, which have an RNA sequence that is complementary to the RNA sequence being tested for," says Fries.

If the RNA being tested for is present, the primer will attach to it, and the ensuing biochemical reaction — aided by the heat and light source — will cause a fluorescent light to be emitted. The final components of the SE 300, a photo detector and optical reader, measure the fluorescent wavelengths and provide a readout on the attached computer monitor.

"The result is a graphical display that reveals the presence and amount of the substance we are testing for," adds Fries.

The entire device is powered by a USB connection from the laptop computer, which also runs the accompanying software.

From Patent to Spinoff

With the prototype complete, Fries began working with USF's Technology Transfer Office (TTO) to patent his technology.

"David is a joy to work with," says McDevitt. "He sees uses for things that no one else would see. He's inventive but practically oriented. He looks for solutions to real problems."

In addition to pursuing a patent portfolio for the portable fluorometer, USF's TTO helped license the technology to a startup company, Bioplex Technologies Inc., based in St. Petersburg, Fla. USF retains an equity share in the spinoff company, for which Fries serves as CEO.

In 2006, the new company set to work refining and readying the device for the marketplace.

Have Fluorometer, Will Travel

McDevitt says it's the portability of the SE 300 that makes the product so useful to a variety of industries.

"This instrument is a mobile lab out in the real world where change is happening," adds Fries. "It allows us to move the lab [to the testing area], rather than taking the sample back to the lab."

The device remains useful in the aquatic world, where it can monitor beach and water quality for hazards such as the microscopic marine algae that, when highly concentrated, form a toxic red tide that threatens fish and other sea life.

The SE 300 has even greater potential on land — from epidemiology research to science education — where the device can be used in the training of chemistry and biology students. The SE 300 can also be used to help restaurants and others in the food industry confirm the authenticity of seafood species (providing seafood buyers the assurance that they are indeed buying grouper, not cod, for example).

In fact, only the number of chemical assays developed by users limits the utility of the device.

"This is a really versatile and universal device that can be used for whatever you want to detect genetically," says Brian Gregson, project scientist at Bioplex. "The end user can buy an off-the-shelf testing kit or develop their own assay."

Changing the Human Condition

The application for the SE 300 that most excites Fries is in the area of human health: identifying disease in areas with minimal health care infrastructure — from a cruise ship to emerging economies.

"I'm passionate about technology and using it to help change the human condition," says Fries. "It will be satisfying from a company standpoint when we're able to fully implement our health care applications."

To that end, Fries — who has been granted 32 patents and cites more than 60 official collaborations thus far in his career — now works regularly with a host of medical doctors.

"I think an engaged scientist has to be self-critical and open to input," he says. "Working with others, I know I can come up with something better than working alone."

The SE 300 offers the ability to quickly test for bacteria and viruses at the point of care, providing results in as little as

45 minutes versus days or weeks for culture-based sample testing in a lab petri dish.

With a small stool sample, for example, the device can test for the enterovirus, a disease-causing bug that affects millions worldwide each year and often flourishes in closed settings such as cruise ships. Alternatively, for HIV testing, all that's required is a simple finger prick yielding a drop of blood from the patient.

Bridging the Health Care Gap

"In remote areas without distribution networks to transport biological samples to a laboratory, the SE 300 fills a need with its portability and low cost," says Fries.

Gregson says the Bioplex device has many advantages over other genetic tests, beginning including a price tag of $2,500 and low power requirements.

"The fact that the SE 300 runs on low power gives it a lot of utility to do tests right in the field, without having to bring in a lot of lab equipment and power generators," says Gregson. "Our device can run on a 9-volt battery and, together with the reagents, it fits in a backpack."

Another plus is the fact that a Western-trained physician or doctoral student isn't required to operate the SE 300 — local health care workers can be trained to use the portable fluorometer, including mixing the sample and setting software parameters. As a result, Fries says doctors who are using telemedicine to reach patients in remote areas via Skype can complement the visual evaluation by using the SE 300 to obtain microbial information.

"Combining a portable fluorometer with Skype is more cost-effective than spanning the gap [between doctors and patients] by building roads, hospitals and labs," says Fries.

On the Horizon

Another handheld fluorometer that can hold up to four test tubes is currently in the works at Bioplex. Gregson says the larger unit will not only increase the throughput potential of the testing device, it will also allow for conducting simultaneous tests on multiple biological samples from a single individual.

"Dengue fever has several variants, so a multichannel device could test for each variant at the same time," explains Gregson.

Bioplex is also actively exploring partnerships with other technology companies to more rapidly expand its product line.

"The future looks pretty good," says Fries. "We know there is a real need for the SE 300 in the environment, but the real impact of this technology will be when people in emerging economies start to benefit."

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