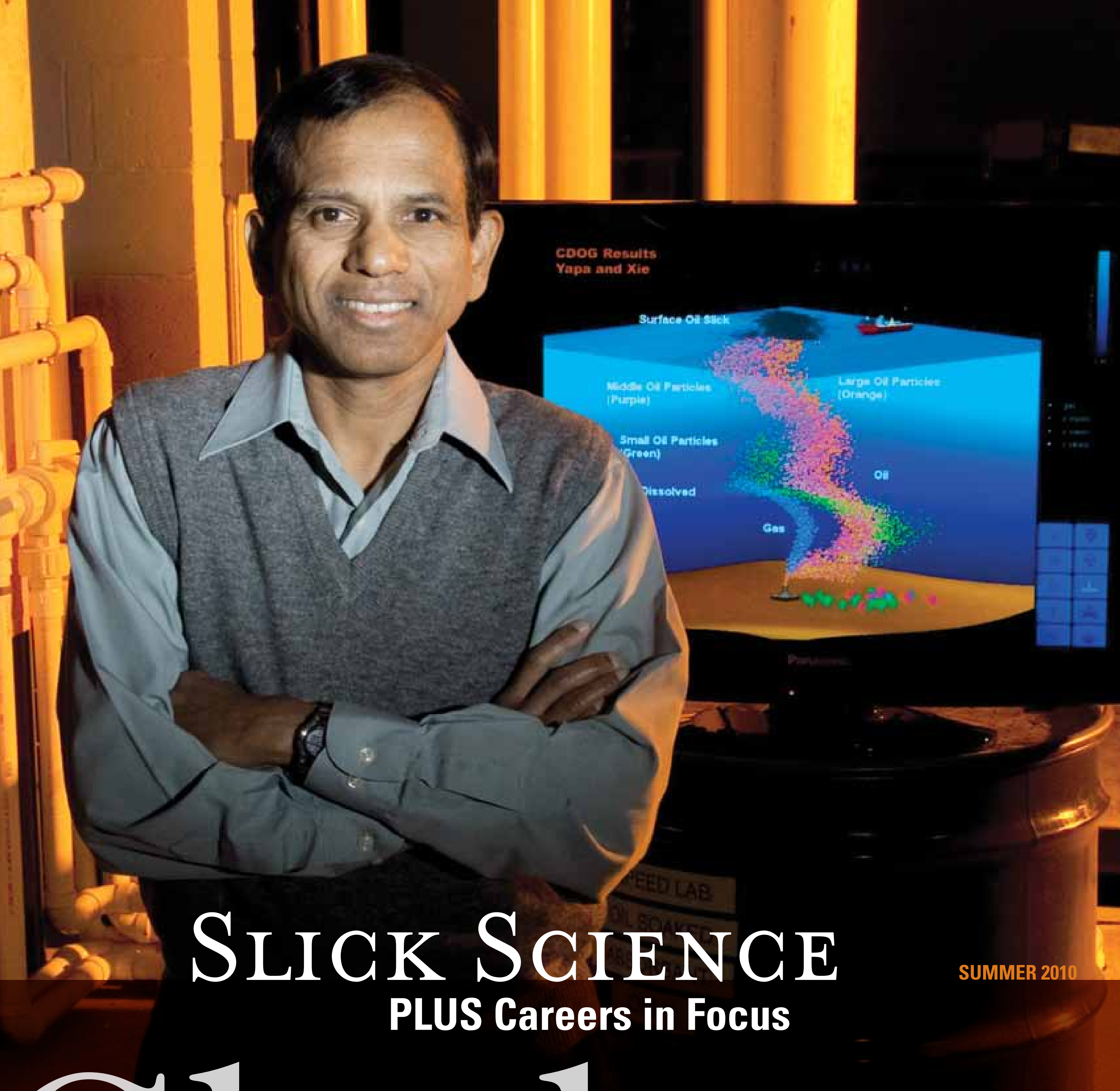

Slick Science

PLUS Careers in Focus

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Clarkson

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by Doug McInnis

EIGHT WEEKS AFTER THE Deepwater Horizon rig explosion, the federal government estimates that up to two-and-a-half million gallons of oil a day have been pouring into the gulf.

In an effort to aid cleanup efforts, the National Oceanic and Atmospheric Administration (NOAA) is using the deepwater oil and gas spill computer model CDOG developed by Clarkson Professor Poojitha Yapa to help predict where slicks will surface and track their movement.

Prof. Poojitha Yapa

(above) Oil washes ashore from the Deepwater Horizon spill.

A week after the April 20 explosion on BP's Deepwater Horizon drilling platform unleashed the worst oil spill in U.S. history, federal officials called Clarkson University. They sought the help of Civil Engineering Professor Poojitha Yapa, one of the world's top experts in the undersea movement of oil from deep-water leaks.

Government officials had long known a disastrous spill was possible. More than 10 years ago, the federal Minerals Management Service commissioned Yapa to create a sophisticated computer model that could be used to predict the movement of oil from a deep-sea spill. "They realized that there was no model available should an accident happen," says Yapa, "And they decided one was needed."

Now, federal officials needed Yapa's input to adapt his model to the current spill. The results would help officials pre-position the personnel, equipment and supplies needed to clean up the oil and minimize environmental damage.

When an undersea gusher occurs, the oil and gas released doesn't simply pop to the surface directly above the break. They can be transported long distances by ocean currents before they surface. The difficulty of accurately predicting this movement increases with

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the complexity of the spill, Yapa says. For example, an oil-only spill is easier to model than one that involves the release of both oil and gas. "The presence of gas impacts where the oil will go, and the oil impacts where the gas will go. Every situation is different — it depends on how much gas is in the mix," he says.

But the Deepwater Horizon spill is still more complex. It involves not only oil and gas, but possibly gas hydrates as well. Hydrates are a mix of gas and water in an almost solid state that are formed under high-pressure and cold-water conditions. "What you have now is a mix of oil, gas, hydrates and water all moving together," says Yapa. "So you have a four-phase problem. A two-phase problem (such as oil and water) is complicated. A four-phase problem is much more complicated."

Yapa says that dispersants used by BP to break up the oil — in order to minimize the damage it might cause — adds another layer of complexity. Dispersants transform oil droplets that normally range in size up to 10 millimeters in diameter into tiny drops with diameters as small as 100 micrometers — roughly the thickness of a human hair. Adjustments have to be made in the model to account for this. "At the time this model was created about 10 years ago, nobody thought about dispersants," Yapa says.

Yapa's model utilizes data on water currents, water temperature and salinity — all factors which help determine the underwater movement of oil and gas. Fortunately, federal agencies closely monitor the Gulf of Mexico, and that data was available for the Deepwater Horizon spill.

But the model also depends on accurate estimates of the volume of oil and gas flowing from the undersea break — and these are difficult to calculate in a crisis. "If you give the wrong estimates for the flow rate, then the results will be wrong to the extent that the flow rate data is wrong," Yapa says. Estimates of oil and gas escaping from the Deepwater Horizon break have varied widely.

With accurate data, however, the model has a good chance of working, according to deepwater tests conducted earlier. "When the model was completed, it was decided that field experiments were needed, not just lab experiments," Yapa says. But the tests

  

(l to r) A large tarball lies on the deck of a boat in the Gulf of Mexico; substantial amounts of oil invade a beach on Queen Bess Island, off the Gulf in Louisiana; oil-covered pelicans wait to be cleaned at Fort Jackson Wildlife Rehabilitation Center in Buras, Louisiana.

"When the model was completed, *it was decided that field experiments were needed, not just lab experiments," Yapa says. But the tests couldn't be done in this country. "You can't spill a single drop of oil in U.S. waters," he says. So, the model was tested with data from the North Sea off the coast of Norway.*

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Three sets of tests, known as Deepspill tests, were sponsored jointly by the U.S. government and an oil industry consortium, all at a depth of 2,700 feet. In one test, oil was pumped down and released. In a second test, only gas was released. In the third, a mixture of oil and gas was released. Observers then monitored the movement of the three releases and compared the actual findings against what the model predicted. "Those tests showed that the model worked," Yapa says.

This doesn't mean that the model is foolproof. "None of these predictive models are exact," says Yapa, who has also worked on oil spill models for Singapore Harbor, Brazilian waters, and the St. Lawrence River. "I compare them to efforts to develop weather-forecasting models. A lot of money has been spent on weather forecasting, but it's still not an exact science. This is not an exact science either." Yapa says the model could be improved with experience. "We don't have the data from the current spill yet, but if it becomes available the lessons learned here will help refine the model."

"Those tests showed *that the model worked," Yapa says.*

Despite higher mileage cars and other energy-saving measures, oil consumption has increased decade by decade. "The U.S. is using much more oil than we did when the first oil crisis hit in the 1970s — not only the U.S., but other countries as well," Yapa says.

To keep up with demand, oil companies have increasingly looked offshore. For instance, about 30 percent of U.S. domestic oil now comes from offshore production in the Gulf of Mexico, according to recent estimates from Interior Secretary Ken Salazar.

"If you look at the last 10 years, there has been a tremendous increase in deep-water exploration," says Yapa. "And it's not going to stop, because the world needs oil and gas. If we keep using it, we have to get it from somewhere." ✦

Aerial view of the site where BP's Deepwater Horizon drilling rig exploded and sank off the coast of Louisiana.