Engineering

Improving Coal Preparation and Miner's Health

The health of the mining industry and the health of miners are the dual focus of three projects under way in UK's mining engineering department. The Advanced Surface Enhancement Project involves using infrared and laser-based technologies to create a molecularly smooth, hardened surface that will decrease the wear and corrosion rate of coal-preparation plant equipment, and may decrease plant maintenance by 20 percent.

A second project is developing new, automated methods to recover coal from abundant thin seams (many of the thicker reserves have been depleted), and improving methods of handling coal slurry to minimize the need for impoundments and guarantee their integrity.

Due to advances in remote-controlled equipment, longer cuts are possible in underground coal mines. However, extended cuts can present problems for the ventilation system.

Meeting this challenge, a third project by mining engineers at UK has resulted in improved ventilation for miners by reducing methane concentrations to safe levels at the face of underground mines where extended cuts are made. Mining engineer Andrzej Wala has been using Computational Fluid Dynamics (CFD) to analyze complex airflow fields and various contaminants at the mine face. His research has shown that CFD is an effective analytical tool for mining engineers to use to create safer, more productive, and environmentally friendly underground mines.

The Metaverse: Visualization & Virtual Environments

A forest fire rages and UK mechanical engineer Jim McDonough is right in the thick of it. But his skin doesn't feel the flames and his lungs aren't choked by the smoke—this is a "virtual" fire. He's surrounded by a life-size image of the blaze, projected on the walls of an ordinary room. As he is "immersed" by the fire, he observes how it moves and discovers how to control it.

This new "virtual reality" using front-projected computer images to immerse the viewer in a pixel-based world—called the Metaverse—was created in 2001 by UK computer scientists Jim Griffioen, Ken Calvert, Zongming Fei, Christopher Jaynes, and Brent Seales. This work, backed by the NSF, led to a number of applications—teleconferencing, scientific modeling, virtual art exhibits, digital library collections, and virtual surgery—and grew into the UK Center for Visualization & Virtual Environments.

Two of the leading-edge projects at the center include Ruigang Yang's work on 3-D reconstruction and Samson Cheung's work in surveillance privacy protection. Yang (computer science) specializes in acquisition—capturing the 3-D image of an object using a group of cameras. His hardware then routes the resulting pixels to a "light portal," a 3-D display.

Cheung (electrical and computer engineering) is creating software that can manipulate video surveillance all the way down to the pixel level. For example, surveillance footage is needed for a jury trial. To protect the identity of bystanders in the video, Cheung can "erase" these individuals, and embed their images into a secure watermark. The complete video can be restored, if needed. Cheung's work is addressing society's need for greater surveillance at home and work, but without compromising the right to privacy.

To protect the identity of bystanders in surveillance footage, UK's Samson Cheung can "erase" individuals and embed their images into a secure watermark.

50 percent of the energy consumption in the automobile assembly process is taken up by painting

Partnering with Toyota

Sometimes serendipity becomes an important matchmaker. This was the case for UK mechanical engineer Kozo Saito, who crossed paths with Fujio Cho at a meeting of the Japan Club of Central Kentucky 20 years ago.

Cho, then president of Toyota's Georgetown, Kentucky, plant (and now chairman of the board of Toyota Motor Corporation) asked Saito about his current work at UK. Their conversations continued and, 10 years later, led to a solution to one of the automobile industry's most costly problems—the waste of electrical energy and paint during the coating process.

"Close to 50 percent of the energy consumption in the automobile assembly process is taken up by painting," Saito says. "Wasted paint due to overspray costs nearly $1 billion a year for a typical, large automobile company." Saito responded to this challenge by developing a much more efficient scrubber for the painting process. Scrubbers suck up, much like a vacuum cleaner, the wasted paint.

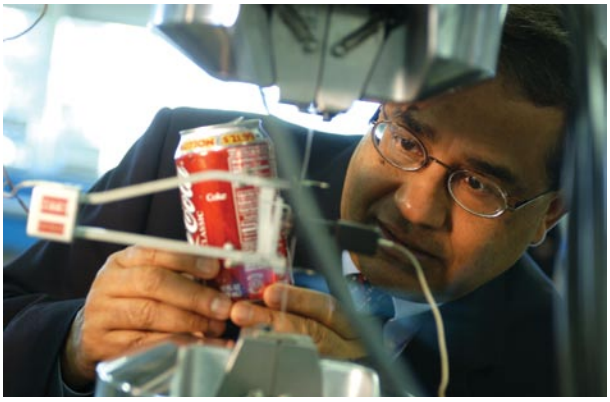
A few months later, based on graduate student Abraham Salazar's computational fluid dynamics model, Saito developed the Vortecone Scrubber, which looks a bit like a four-foot-tall meat grinder. The patented device has significantly improved overspray capture while using much less energy than conventional scrubbers. "Paint capturing efficiency is 98.2 percent, and the Vortecone uses half the energy that's sapped by old-style scrubbers."

Saito's scrubber is currently being used in seven Toyota facilities worldwide, including the headquarters plant, and the UK-Toyota partnership continues to flourish. Last March, Toyota gave UK $1 million to support a new Institute of Research for Technology Development in the College of Engineering, to be headed up by Saito.

Partners in Aluminum

From its founding in 1999, the Center for Aluminum Technology (CAT) in UK's College of Engineering has had a targeted mission: to partner with industry to make advances in the aluminum industry that benefit all of us. "Here at UK's Coldstream Research Campus, we provide the brainpower to work on problems that the industry identifies," says Subodh Das, center director, "and then industry can apply this basic research and roll it into actual production."

Today, the results of some of CAT's first projects are reaching fruition. One of the center's original projects, completed in 2004, focused on lowering incidents of aluminum ingot cracking to save energy and costs. In partnership with seven companies and organizations, CAT developed mathematical modeling software that can predict cracking propensity. The software evaluates casting speed, metal temperatures, and a variety of other casting parameters. "Using this software, we were able to achieve lower cracking by 50 percent, and we created a tool that is now available for use by the entire industry," Das says.



Business and economics and engineering faculty partner with CAT through UK's Sloan Center for a Sustainable Aluminum Industry. Ten current research projects include recycling programs, aluminum energy efficiency, continuous casting of aluminum, and the use of aluminum in the automotive industry.

"CAT is the premier technology and business research organization in the world for aluminum research," Das says.