Pictures of the Future

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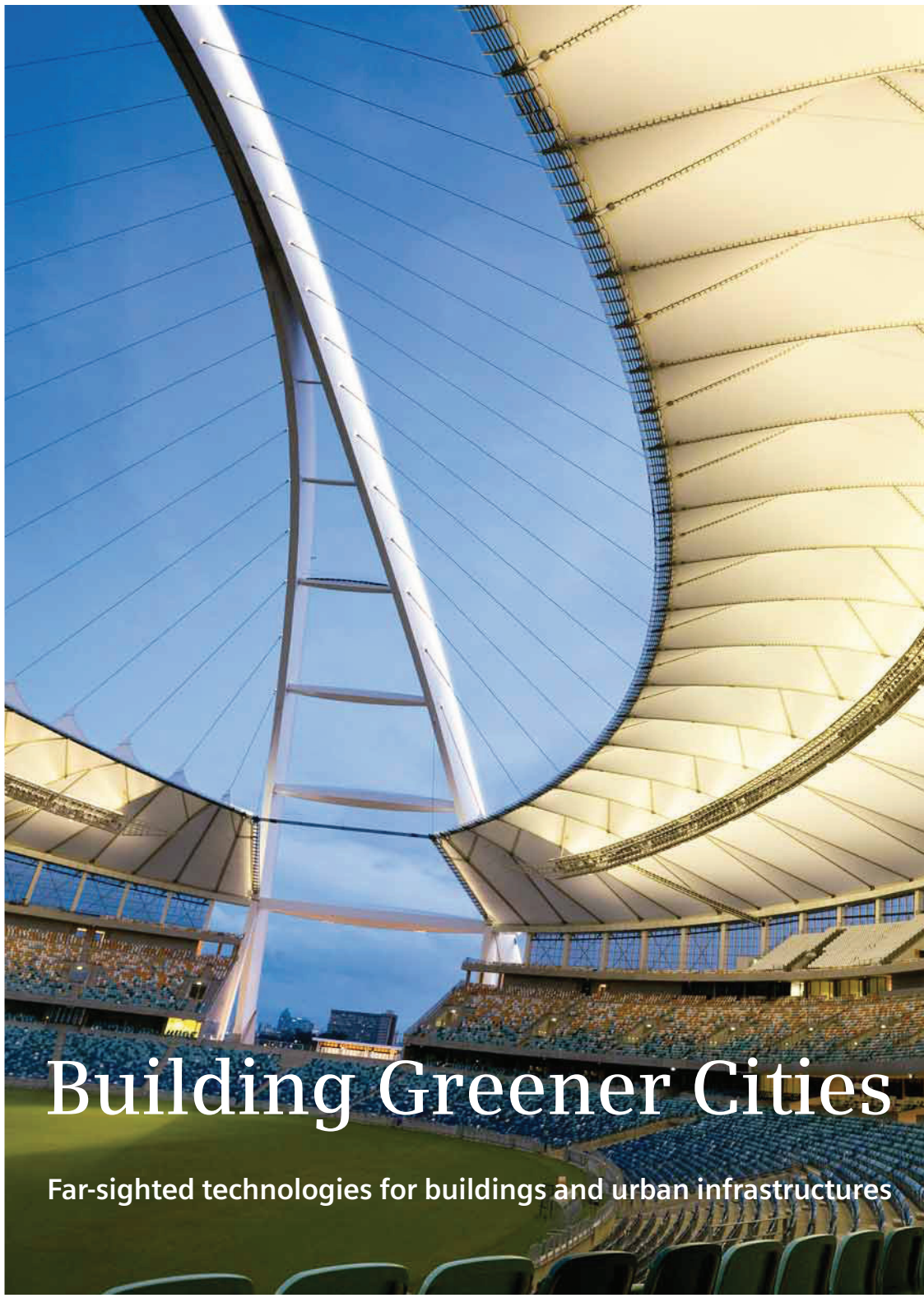
Molecular Detectives

Targeting pathogens and pollutants with new technologies

Open Innovation

Cost-effective, collaborative roads to knowledge



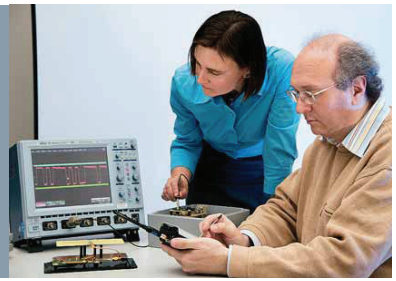
Building Greener Cities

Far-sighted technologies for buildings and urban infrastructures

Cameras that combine thermal and video images can identify otherwise invisible sources of danger. CT researchers (right) check the functions of an RFID chip designed to detect trucks carrying hazardous freight.

Danger Made Visible

A truck with a defective engine, faulty brakes, or hazardous freight can trigger an inferno in a tunnel. Siemens researchers are investigating how to use RFID technology, video analysis, and thermal imaging cameras to spot vehicles that are at risk.



The driver of the tanker truck doesn't know that he's heading for disaster. He's unaware that the braking system on one of his rear wheels is blocking and beginning to glow red hot. There's a tunnel coming — in three kilometers — but the potential catastrophe doesn't have a chance to unfold thanks to newly developed safety systems that have already detected the rolling time bomb and triggered an alarm in the tunnel operator's control center. Here, staff switch the lights at the tunnel entrance to red, and flashing hazard signs redirect the driver in order to defuse the dangerous situation.

This scenario is still a future vision. Nevertheless, a research project known as SKRIBT — (German acronym for "Protection of Critical Bridges and Tunnels on Roads") — which is being conducted by scientists at Siemens Corporate Technology (CT) and its Mobility Division, is moving closer to making this vision a reality. Ten partners from government agencies, industry, and research institutes are participating in a three-year project, which is being funded by the German Ministry of Education and Research. The aim is to make critical road segments safer. "Tunnels and bridges are the most important components of the road network," says Dr. Frank Heimbecher, project coordinator at Germany's Federal Highway Research Institute, which initiated the SKRIBT project. "If they get damaged, the consequences can be economically devastating."

Most major accidents in tunnels involve defective trucks — situations in which tires blow, brakes overheat, or engines fail in a manner that triggers a fire. That's why Alla Heidenreich, infrastructure project manager at Siemens CT, has been working with her team since 2008 on two safety systems that can identify defective trucks and those transporting hazardous materials — before they enter a tunnel. The researchers, who are from Munich and Princeton, New Jersey (USA), came up with the idea of combining video images with thermal imaging technology. This enables them to determine if certain vehicle components are overheating. The system works as follows: A video processing program linked to surveillance cameras identifies a passing truck and converts a segmented two-dimensional image of it into a 3D model with using newly-developed algorithms. The program is then able to recognize components susceptible to fire, such as wheels, brakes and axles.

The thermal image of the truck, which is recorded using an infrared camera, is linked with the 3D image, after which an analysis program searches for anomalies that could indicate defects. It does this using knowledge gained from models that provide information on things such as how hot one axle may get in relation to the others. Because normal video cameras need expensive external lighting at night, Siemens researchers are working on yet another idea. "Our next step will be to study possibilities for the exclusive use of infrared images to identify potentially dangerous situations with tires, brakes, and axles," says Dr. Andreas Hutter, an expert in realtime image processing. "If we succeed, we'll be able to significantly reduce costs."

Hazardous material transports pose an even greater problem, especially if it's not clear what type of cargo is being shipped. Some materials like gasoline may only be transported by truck through certain tunnels. Up until now, there has been no automated system for monitoring compliance with such rules. Trucks today are in fact required to carry orange stickers bearing coded information on how dangerous their freight is and which categories of tunnels they may pass through. However, video cameras can not decipher these labels when visibility is poor or the labels are covered with dirt. Radio Frequency Identification (RFID) transponders would thus offer a major benefit here.

Transmission-Enabled Stickers. If experts at CT have their way, trucks will soon also be equipped with hazardous material labels containing a small RFID chip that can be read via radio and that also holds all information about what the truck is carrying. "That would significantly increase the accuracy of the monitoring system," says Heidenreich. Such a system would function roughly as follows. When a truck passes a reading point approximately three kilometers before a tunnel, its cargo data would be registered by the RFID system and forwarded to a control center. Only one truck transporting hazardous materials would be permitted in the tunnel at a time. Should an accident occur, firefighters would tackle the blaze using precisely the right extinguishing agent. Any truck attempting to enter a tunnel with prohibited freight would be stopped by a red light in front of the entrance.

The CT team is particularly proud of its newly developed RFID transponder system's ability to meet extremely high demands. The chip can transmit its signal to the unit's reading device over a distance of around 50 meters — and send the data at least twice within two seconds. "Conventional passive radio chips without a built-in energy source have a range of only six meters," says Daniel Evers, an RFID expert at CT. "That's why we use an active chip that has a built-in battery and transmits in the high-frequency range of 2.45 gigahertz. To ensure the battery lasts as long as possible, the transmitter in the transponder sleeps until it's woken by a radio pulse issued by the reading device at the checkpoint." Evers also points out that the RFID data cannot be intercepted or falsified. To ensure this is the case, Siemens researchers employ an encryption technique they previously developed for passive RFID chips (see *Pictures of the Future,* Spring 2009, p.45). "Previous solutions needed too much energy," says Hermann Seuschek, an IT security expert at CT. "However, our cryptochip is so energy efficient that the transponder can run for at least three years without needing a replacement battery."

Research activities will be followed by road tests in mid-2010, when Siemens researchers will install truck detection system components at the Aubinger Tunnel near Munich. Plans call for the tunnel safety system to be tested until February 2011. "Up until now, activities have focused on improving safety within the tunnel," says Heidenreich. "But in the future, we're going to be able to detect and prevent danger before a vehicle gets there. Video, RFID, and infrared technologies will play a key role in this process."

Rolf Sterbak

In Brief

■ Researchers are pushing deeper into the nano worlds of cells, proteins and genes. To this end, technologies are being developed that will make diagnoses faster, more reliable, and less expensive. Siemens researchers are, for example, working on a portable system that could instantly test a drop of blood for the presence of a range of diseases. (p. 62, 66)

■ In an interview, Dr. Charles M. Lieber of Harvard University states that in perhaps five years it will be possible to locate tiny sensor systems underneath a person's skin, where they would continuously check his or her blood for biomarkers of diseases such as cancer or flu. (p. 65)

■ Having the right kind of diagnostics is essential when combating cancer. Siemens is combining 3D X-ray images from computer tomographs with positron emission tomography images used in nuclear medicine. Result: doctors can more quickly and effectively determine the size and location of dangerous tumors. (p. 68)

■ Infrared light can be used to discover molecules and thus optimize processes. Siemens experts are using infrared spectroscopy to help regulate coal-fired power plants more precisely and prevent failure in biogas fermenters. (p. 70)

■ ESA employs earth observation satellites to gather data about the interrelationships between volcanic eruptions, earthquakes, and climate change. Siemens is developing special test systems to ensure the huge volumes of data gathered by satellites make it securely to earth. (p. 72)

■ Time-consuming lab tests are currently required in order to detect pollutants in water and air. Siemens researchers have developed several sensor systems that detect dangerous substances such as pathogens and pollutants quickly and directly on site. (p. 74)

■ Trucks with defective engines and brakes could trigger an inferno in a tunnel, as could trucks transporting hazardous freight. Siemens researchers plan to use RFID technology, video analyses, and thermal imaging cameras to identify at-risk vehicles and thus prevent disasters from occurring. (p. 78)

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