Photo courtesy of Department of Homeland Security Science and Technology Directorate

R-TECH™ NEWSLETTER
The Newsletter of the First Responder Technologies Program

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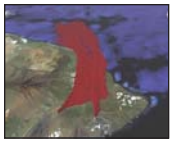

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This Newsletter discusses technologies of interest to first responders that have received funding, in part, from the Federal government. Mention of these technologies should not be construed as an endorsement of either the technology, or the entity producing it, by the Federal government.

To download a copy of this newsletter, visit:
http://www.firstresponder.gov/Pages/NewsLetterPage.aspx?NewsLetter=current

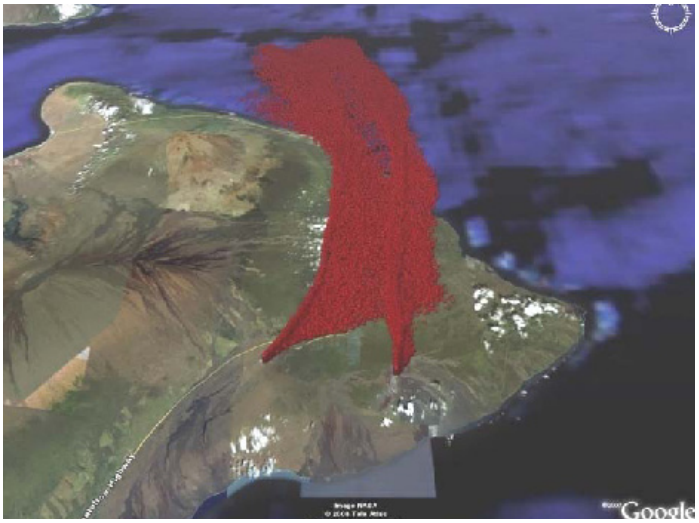
ATMOSPHERIC DISTURBANCE

Federal Center Helps Predict Dispersion of Atmospheric Hazards

When thousands of chemical storage drums in an Ohio container recycling facility erupted in flames one evening in August 2004, Cincinnati faced a fire generating large quantities of potentially toxic smoke that rapidly spread across residential and business sections of the city. Fearing the airborne plume could pose a danger to citizens, Cincinnati officials turned to the Interagency Modeling Atmospheric Assessment Center (IMAAC), which provides atmospheric hazard predictions under the auspices of the Department of Homeland Security (DHS). Cincinnati officials needed to learn the estimated chemical concentration of the smoke and the direction it would spread to determine the need for evacuation or other protective actions.

Within minutes of receiving notification of the Queen City Barrel Company chemical fire, IMAAC provided initial predictions about the size and direction of the toxic smoke plume. City officials used this information to develop a shelter-in-place strategy for occupants in the affected areas. According to Ed Dadosky, District Fire Chief for the Cincinnati Fire Department, "[IMAAC models] were driving much of the decision-making and incident-specific information disseminated to the public."

IMAAC scientists at Lawrence Livermore National Laboratory (LLNL) in Livermore, Calif. provided forecasts of the likely changes in the plume's path as wind conditions shifted the predicted course from northeast to southeast.



The Interagency Modeling Atmospheric Assessment Center accurately predicted the sulfur dioxide plume released from two volcanic vents in Hawaii in 2008 using in-house special high-resolution Weather Research and Forecast (WRF) model simulations. Image courtesy of IMAAC.

They also refined their predictions of potential impacts based on chemical inventory information and field measurement data provided by Cincinnati responders. Fortunately, the chemicals in the plume did not require evacuation. "This was an excellent demonstration of the value IMAAC can provide to local responders and the importance of the working relationships between federal resources and emergency responders," said Dr. Gayle Sugiyama, National Atmospheric Release Advisory Center (NARAC) and IMAAC Program Leader at LLNL.

DHS established IMAAC in 2004 to coordinate the generation and dissemination of federal plume models and provide atmospheric hazard predictions to state and local governments during major incidents. IMAAC is a partnership between DHS and seven other federal agencies: the Department of Energy (DOE), the National Oceanic and Atmospheric Administration (NOAA), the Environmental Protection Agency (EPA), the Department of Defense (DoD), the National Aeronautics and Space Administration (NASA), the Nuclear Regulatory Commission (NRC), and the Department of Health and Human Services (HHS). This partnership is guided by the leadership of IMAAC Director Nicholas L. Wong, a U.S. Coast Guard Lieutenant Commander detailed to DHS' Office of Operations Coordination and Planning (OPS).

Using resources from federal partners, IMAAC Operations at LLNL produces and distributes predictions for atmospheric hazardous material releases during incidents requiring federal coordination. LLNL provides an around-the-clock facility with subject matter experts, computer systems, and Internet-based remote access to request and share plume modeling simulations and analyses. Scientists at LLNL gather information about an airborne hazard, such as where, when, what, and how much material was released. This is combined with meteorological and geographical data to calculate the dispersion of the material and the results are processed with other data, such as health effect levels and population, to generate plume model graphical plots – maps showing the affected areas and likely impacts of the release. Plume modeling results help first responders make decisions on protective actions, safe locations for incident command posts, and guidance for monitoring teams sent to obtain chemical samples. Sugiyama said, "Early in an incident, the IMAAC models provide key information to first responders to make potentially life-saving decisions."

Atmospheric Disturbance (continued)

Key leaders and decision-makers who do not have a technical background might need additional assistance in interpreting the plume products. IMAAC Operations staff and other interagency experts are available to provide interpretations. In addition, DHS and DOE are leading efforts to produce IMAAC "plain language briefing products," which are used to brief public officials and facilitate public safety recommendations. These products use non-technical language, highlight key points, and cite the guidance being used to create the product. They are designed to complement IMAAC technical products, not replace them.

Local agencies rely on IMAAC for advice during an emergency. When a fire broke out at Valley Solvents and Chemicals in Fort Worth, Texas in July 2005, city officials worked with IMAAC to determine the likely size of the plume. Based on predictions that the release could send hazardous potassium hydroxide up to five miles downwind, officials recommended residents within that range shelter in place. "During real events, it's incredibly valuable," said Keith Wells, Senior Emergency Management Officer at the Fort Worth Office of Emergency Management.

Fort Worth officials also collaborated with IMAAC during the planning for a downtown high-rise building demolition. IMAAC developed model simulations predicting how dust would disperse during the explosion. The city used this information to determine where to place barriers around the site and to locate seating areas for observers. The model result was remarkably close to the actual size of the dust cloud, Wells noted.

IMAAC technology and expertise has been applied to natural disasters as well. In 2008, IMAAC was called upon to provide 24-hour forecasts of the plume resulting from unusually large releases of toxic gases from two volcanic vents on Hawaii's Big Island. Wind conditions were transporting the plume in the direction of the city of Hilo. LLNL staff members worked closely with the EPA, the National Park Service, the U.S. Geological Survey, the National Guard Civil Support Teams, and the state and county governments in Hawaii. IMAAC's plume modeling assisted local first responders in determining what parts of the island might be exposed to dangerous levels of sulfur dioxide during the venting of Kilauea and Pu'u O'o.

IMAAC is also an invaluable tool for the preparedness community, capable of generating assessments and scenario predictions for disaster planning, National Special

The Interagency Modeling Atmospheric Assessment Center supported the EPA's response to a major volcanic eruption at Hawaii Volcanoes National Park. Image courtesy of IMAAC.

Security Event (NSSE) contingencies, or training exercises, from simple drills to current national level exercises. According to Daniel Blumenthal, DOE Consequence Management and NARAC Program Manager, IMAAC can prepare plume modeling simulations for a potential disaster to assist first responders and emergency planners in developing plans. "Before anything ever happens, IMAAC helps responders in developing their response plans and work on preparedness," he said. "If someone is concerned about a potential release, IMAAC can run a calculation and provide estimates of what might happen."

If first responders find themselves responding to an emergency situation involving a major hazardous release to the atmosphere where lives are at risk and federal dispersion modeling assistance would be beneficial, they should contact one of the following operations centers to request IMAAC support:

- For emergencies only – IMAAC Operations, 925-424-6465.
- For federal assistance with a major incident or weapons of mass destruction incident – DHS National Operations Center, 202-282-8101.

"One of our priorities is to expand the awareness of IMAAC amongst the preparedness and response community so they understand what it is and when it may be appropriate to use it," Wong said.

For more information, visit http://imaacweb.llnl.gov.

CONNECTING THE DOTS

Visual Analysis Tool Highlights Links Between Crimes

The file for a police investigation can contain thousands of pages of interview notes, forensic reports, and other documents. The file's sheer size makes it challenging for police to identify which details might be crucial to solving the crime or how they might relate to other crimes.

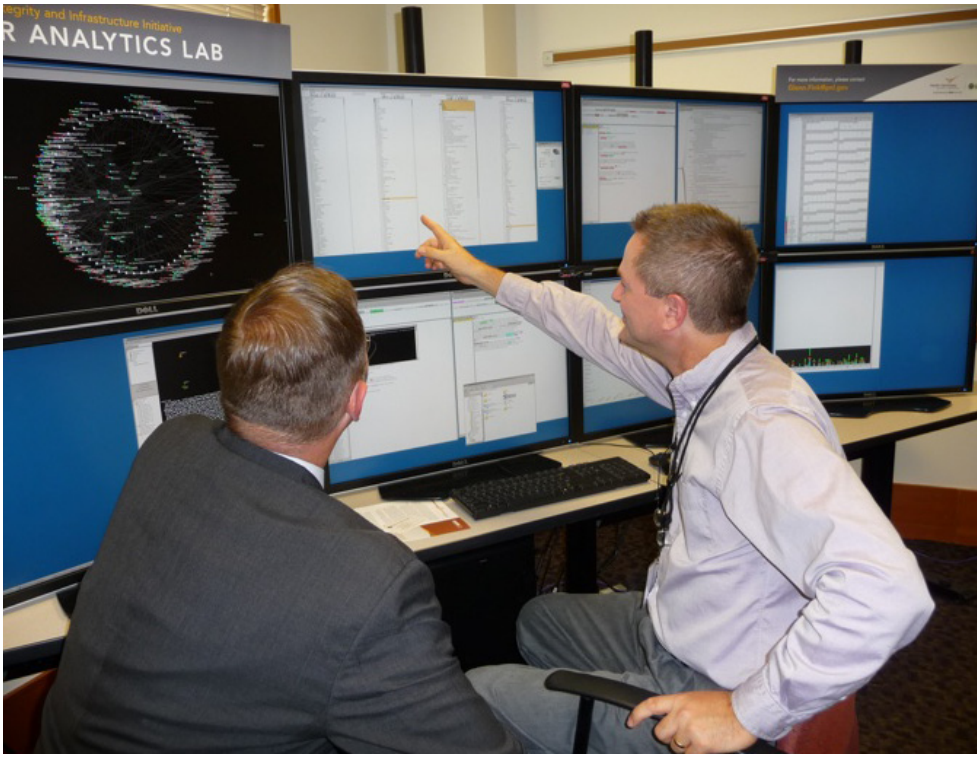
A software program, called Jigsaw, analyzes documents and creates charts to show connections between the files. Developed at the Georgia Institute of Technology – a university that is part of the new Department of Homeland Security (DHS) Center of Excellence in Command, Control, and Interoperability – Jigsaw allows law enforcement officers to observe connections between large numbers of documents and make sense out of them, said John Stasko, Professor and Associate Chair of the Georgia Institute of Technology School of Interactive Computing.

The Georgia Institute of Technology developed the software using funding from the DHS Science & Technology Directorate (S&T) Threat Awareness Portfolio; DHS S&T Command, Control and Interoperability Division (CCI); DHS S&T Office of University Programs; and the National Science Foundation.

Developed two years ago, Jigsaw relies on the principle "a picture is worth 1,000 words." People who struggle to see the connections among 2,000 numbers in a list can easily see a pattern when those figures are transformed into a chart. Presenting a mass of data in a visual format helps viewers make sense of the information. According to Stasko, "When data gets big and diverse and is streaming in, it really helps to have technology that can do computational analysis and present it in visual form."

Jigsaw combs documents for information and charts the connections it finds. Stasko said that users can import plain text, PDF, Microsoft Word, or online files into the program for analysis. Jigsaw then hunts through those files for common dates, names, or places, and diagrams those connections in several ways. Users can view scatter plots and graphs that illustrate links between people, places, and dates. The diagrams can show when suspects visited a certain city or whether two suspects are associated. Once police identify the connections, they can decide how to focus the investigation.

The connections Jigsaw illuminates could help law enforcement officers investigating criminal organizations that operate in more than one jurisdiction, said Dr. Joseph Kielman, Basic and Futures Research Lead for CCI and Program Manager for the DHS Center of Excellence in CCI. Law enforcement agencies collaborating to investigate drug rings, terrorist groups, or other criminal organizations could use the software to draw connections between reports from different jurisdictions. According to Kielman, "Those [groups], in many cases, cross borders. They're not just in one city, one state, one country. Jigsaw helps make those connections."

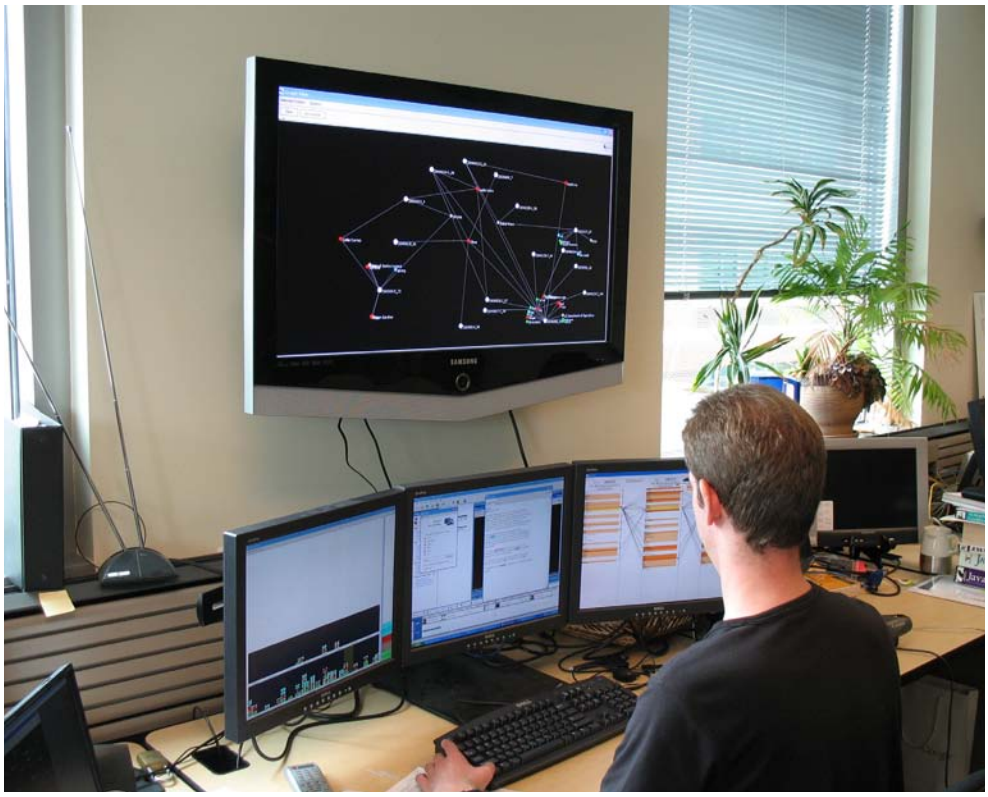


The Jigsaw software program charts information to show the ties between law enforcement reports. Photo courtesy of Georgia Institute of Technology.

Connecting the Dots (continued)

Criminal organizations that operate across a broad geographic region also tend to be involved in multiple kinds of crime, said Kielman. A terrorist group or drug ring could commit robberies to finance other crimes, for example. Jigsaw could help law enforcement agencies identify these interrelated crimes. "If you can't make those connections, you can't see how broad these criminal activities really are," Kielman said.

Jigsaw software demonstrations have been held at several conferences, including the Technologies for Critical Incident Preparedness Conference and Exposition held in October 2008, according to Kielman. Researchers also held a demonstration at the University of Konstanz in Konstanz, Germany, in June 2009.



A computer station with multiple monitors allows Jigsaw software users to simultaneously study data in different visual formats. Photo courtesy of Georgia Institute of Technology.

Kielman wants to give first responders the opportunity to test the software in the next year. Currently, the Georgia Institute of Technology can provide prototype copies to first responders interested in testing out the program, Stasko said.

The software prototype has limitations, however. According to Stasko, Jigsaw can only read certain types of text files, and some police departments have limited resources to devote to converting documents into one of those formats. Moreover, to make best use of the software, police need a computer station with multiple monitors. Without a multiple-monitor display, it can be difficult to simultaneously examine the charts Jigsaw creates. The software would work best in an operations center or intelligence office that has multiple computer screens, Stasko said.

In addition to serving first responders, Jigsaw has potential applications for the intelligence community. Analysts could use the software to spot connections between field reports, newspaper articles, and other documents, Stasko said.

Police officers will find Jigsaw's concept familiar, as they already employ a low-tech form of visual analysis, according to Stasko. Using a bulletin board to post photographs or other documents from a case is similar to the way Jigsaw analyzes data. Police can see connections more easily when the evidence and data is spread out in a way that allows them to visualize ties between suspects. Jigsaw provides a similar analysis of law enforcement files, on a wider scale. Stasko said, "No particular document spells out all of it, but many, many documents have a little piece of the story."

For more information, visit www.gvu.gatech.edu/ii/jigsaw.

FLOOD GATES

Water Harnessed to Block Levee Breaches

When rivers rise, threatening to sweep away lives and property, first responders rely on stacks of sandbags and rocks to repair breaches in levees. However, that process can take days to stop water from rushing through the breach, damaging infrastructure and homes. Researchers, with guidance and financial support from the Department of Homeland Security (DHS) Science and Technology Directorate (S&T), are developing ways to harness a more powerful force to stem the flow of water – the water itself. The resulting inventions will reinforce the nation's nearly 100,000 miles of levees, which protect residents and millions of dollars worth of infrastructure.

DHS and the U.S. Army Corps of Engineers (USACE) Engineering Research and Development Center (ERDC) successfully demonstrated various tools that use water to rapidly repair levee breaches during a Nov. 9, 2009 event at the U.S. Department of Agriculture's Agricultural Research Service Hydraulic Engineering Unit in Stillwater, Oklahoma. The core technology is a tube of non-stretch polyvinyl chloride-coated fabric. Referred to as the Portable Lightweight Ubiquitous Gasket (PLUG), the tube can be dropped from a helicopter or barge and positioned near a levee breach. Emergency responders then pump water into the tube until it is up to 90 percent filled with water, according to Dr. Don Resio, senior technologist with USACE ERDC. The tube forms a barrier that halts the flow of water through gaps in the levee. Because the water inside cannot be compressed, the tube can withstand the millions of pounds of force generated by rushing water during a flood. "For the first time, this device brings some prospect of sealing a breach very quickly during the time the highest [water] flow is going through it," Resio said.

Rapidly halting flooding through a levee breach would limit the damage done by the floodwaters, according to Sonny Fong, executive emergency preparedness and security manager for the California Department of Water Resources (DWR). Along with obvious water damage, levee breaches bring the threat of power outages, infrastructure damage, and toxins contaminating soil and sources for drinking water supplies. The greatest worry is the possibility of rushing floodwaters, which can move at a rate of up to 200,000 cubic feet per second, killing or injuring residents. "If we had that [levee repair] technology, it would reduce the threat to lives," Fong said. "It would reduce the threat to infrastructure. It would reduce the threat to first responders."

Researchers position an arch-shaped cofferdam around a blocked levee breach in Stillwater, Okla. on Nov. 9, 2009. The tool would allow workers to repair a levee breach. Photo courtesy of DHS S&T.

Cleanup and repairs can take months or even years after a levee breach. During Hurricane Katrina, flooding in New Orleans displaced more than 250,000 people, and the death toll exceeded 1,800, according to the National Oceanic and Atmospheric Administration's National Climatic Data Center. The flooding along the Gulf Coast following the hurricane caused about $125 billion in damage. It took almost a week for responders to seal levee breaches in New Orleans using giant sandbags, according to USACE ERDC. If the 17th Street levee breach had been sealed by 1:30 p.m. during the day of the hurricane, it could have prevented $1.5 billion in damage, according to Wil Laska, program manager for DHS S&T's Homeland Security Advanced Research Project Agency. Cleanup and rebuilding continues in the area, years after the 2005 hurricane and resulting floods.

California has experienced devastating floods on a smaller scale, according to Fong. When the

Flood Gates (continued)

Jones Tract levee failed in central California in 2004, water flooded 12,000 square acres of agricultural land. It took 30 days to repair the levee breach and another six weeks to remove water from the sodden landscape – work that cost about $20 million, Fong said. A 2005 damage report prepared for the DWR estimated the flood caused $16 million in damage to crops, infrastructure, and other private property.

Hurricane Katrina's destructive floods inspired DHS to tackle the problem of levee breaches and finding a way to repair them faster. If first responders could block the levee breach quickly, that would limit the extent of the damage and cleanup, according to Laska. When first responders drop sandbags into the water from a helicopter – a typical repair method – it can take days to plug a hole. "Once a breach is detected, we need to seal that breach within four to six hours," Laska said. "After that, it becomes so wide we cannot seal it effectively."

DHS S&T and USACE ERDC started exploring potential solutions to this problem in 2007. Researchers first considered tarps and other materials that could be placed in front of a breach. However, the floodwaters' force was so great that prohibitively large anchors would have been required to hold the tarps in place, Laska said. Tubes filled with water – a resource readily available during a flood – worked better to plug irregular shaped holes in levees.

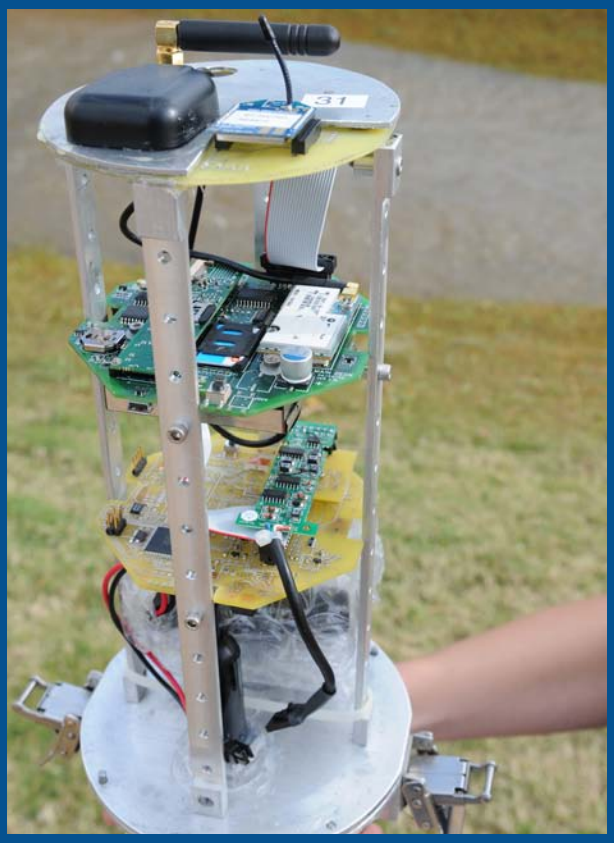
The tests in November demonstrated a PLUG about 20 feet in length, which is considered to be approximately one-quarter scale. USACE ERDC demonstrated other tools including a fabric and tube combination that directs water over the levee to protect it from erosion when overtopping is necessary. They also created an arch-shaped cofferdam – a watertight enclosure that allows engineers to repair levees – called the Rapidly Emplaced Hydraulic Arch Barrier (REHAB). Once researchers put the PLUG in place to stop water from flowing through the levee breach during the demonstration, researchers positioned the REHAB around the PLUG and the breach, Resio said. The PLUG was then removed, leaving a dry area surrounding the breach for repair work. Workers assembled the 40-foot cofferdam in 30 minutes, he said. In comparison, the process of building a traditional cofferdam can take weeks.

Some of the rapid levee repair tools were first demonstrated in Stillwater in September 2008. The

FLOATING BEACONS TRACK FLOOD WATERS

Researchers for University of California, Berkeley (UC Berkeley) demonstrated another flood fighting technology during the Nov. 9, 2009 demonstration. University researchers developed the Floating Sensor Network, a system of floating beacons that track the movement, temperature, and chemical content of floodwaters. The invention, funded by the National Science Foundation, the California Department of Water Resources (DWR), and the California Bay Delta Authority, was developed by UC Berkeley researchers collaborating with DWR and Lawrence Berkeley National Laboratory. Researchers want to build 100 of the beacons in the next few months.

The Floating Sensor Network's beacons can monitor the direction floodwaters are flowing and transmit real-time information to the incident command, said Dr. Alexandre Bayen, professor of civil and environmental engineering at UC Berkeley. The beacons also could be used to track a chemical spill in a body of water. "It's something that works in the field on short notice," he said.



The circuits from a Floating Sensor Network beacon. Photo courtesy of DHS S&T.

Flood Gates (continued)

November 2009 demonstration added instrumentation to measure the strains on the devices and tested the new arch-shaped designs. The successful demonstration showed that, at one-quarter scale, the tools worked. The challenge now is to test full-scale devices – designs capable of blocking breaches the size of the ones that occurred in New Orleans following Hurricane Katrina, Laska said. First, a site needs to be constructed where full-size tools could be tested. A test facility will be built in Vicksburg, Miss. in the next 6 to 12 months in preparation for full-scale testing in the summer of 2010, according to Laska.

The technologies offer promising potential solutions for emergency responders facing future levee breaches, according to Resio. The rapid levee repair tools could be the first major advance in the field since the sandbag. "Our real objective here is to get people thinking about what a new generation of flood fighting alternatives could be," he said.

For more information, visit http://chl.erdc.usace.army.mil/rrlb.

The Portable Lightweight Ubiquitous Gasket stops floodwaters from rushing through a levee breach during a Nov. 9, 2009 demonstration in Stillwater, Okla. Photo courtesy of DHS S&T.

RESPONDER KNOWLEDGE BASE

Product Categories

First responders searching for equipment can find a range of certified products using the Responder Knowledge Base (RKB). The Website, located at www.rkb.us, provides an extensive list of first responder products and technologies. RKB product categories include:

Personal Protective Equipment (PPE): PPE subcategories on RKB include ensembles, respiratory protection, explosive ordnance disposal (EOD) equipment, water operations, and clothing items. Types of respiratory protection products that are listed are: self-contained breathing apparatus, supplied air respirators, air-purifying respirators, powered air-purifying respirators, and escape respirators. Ancillary equipment, such as canisters and facepieces, can also be found in the PPE section. The PPE section also includes footwear, gloves, garments and hoods, eye and facewear, helmets, cooling/hydration gear, and hearing protection product records. There are more than 1,600 product records in PPE.

Operational and Urban Search and Rescue (US&R) equipment: This category comprises a number of sub-categories, including Tools, Robotics, Rope Safety/Rope Rescue Equipment, and Search/Surveillance Equipment, among others. The Tools sub-category contains powered, pneumatic, hydraulic, and hand tools. The Robotics sub-category contains command centers, surveillance platforms, and robots. The Rope Safety/Rope Rescue Equipment sub-category contains ropes, harnesses, hardware, stretchers, litters, and

RKB (continued)

related equipment used for fall protection, rigging, and victim removal. The Search/Surveillance Equipment sub-category contains cameras, thermal imagers, scopes, and lighting systems. Other Operational and US&R sub-categories are Lights and Illumination Equipment; Structures, Shields, and Physical Security Equipment; Ventilation Systems; Vehicles; and Water Operations Equipment. This section is nearing 2,000 product records.

Information Technology: There are more than 600 information technology products on RKB, including cyber security equipment, hardware, software, and other systems including geospatial information systems (GIS) and credentialing systems.

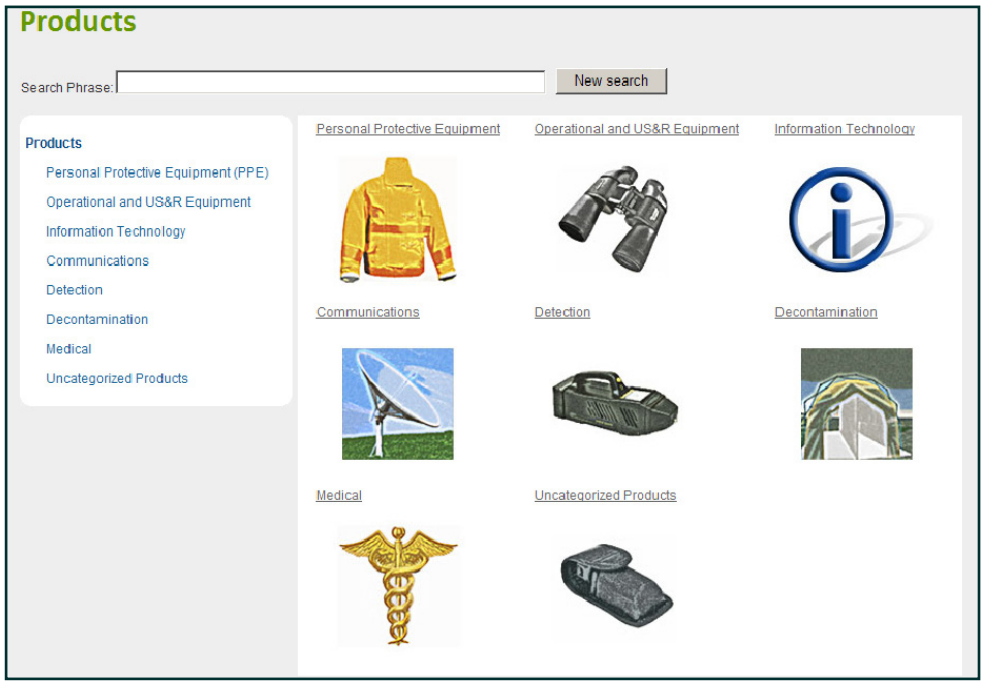
Communications: The communications equipment category contains almost 600 product records. Equipment types include devices that employ one of two communication methods (wireless or wired), different types of equipment (portable radios, mobile radios, base/fixed station radios, and repeaters), and various accessories (examples include speaker microphones, battery eliminators, and carrying cases) and/or enhancements (encryption, digital communications, security measures, and interoperability/networking) to meet the user's needs.

Detection: This category, with more than 850 product records, covers chemical, biological, radiological, and explosive sampling and detection equipment. This includes disposable and portable systems, laboratory equipment, kits, monitors, and blast mitigation equipment.

Decontamination: This section contains more than 300 products and systems used for decontamination in all-hazard environments.

Medical: Medical equipment, supplies, and pharmaceuticals are included in this section. Most items on RKB will be durable equipment or unusual supplies rather than routine supplies and pharmaceuticals. Almost 600 medical products are listed.

Uncategorized Products: This section lists equipment relevant to emergency responder operations that does not fit any of the product categories defined above.

RKB is continuing to modify and expand product categories to best fit user needs and to account for new technologies. Please contact RKB with any new product category suggestions.

For more information on RKB's product categories, visit www.rkb.us. For questions or suggestions, e-mail RKB at RKBMailbox@us.saic.com, or call 1-877-FEMA-RKB (1-877-336-2752).