SENSORS

Sensor Industry in Oklahoma

A new UAS test facility expands Oklahoma's horizons

Oklahoma State University
SENSOR RESEARCH

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ABOUT THE COVER: Oklahoma State University's Pterosoar-B, an unmanned aerial vehicle built by students, flies high above the University Multispectral Laboratories' test site in Chilocco, Okla.

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Expanding Horizons

Growth at Fort Sill paves the way for world-class Unmanned Aerial Systems (UAS) testing, certification and training center

With more than $487 million in construction projects underway, growth and expansion have become the new norm at the Fort Sill Army base in Lawton. Brought about by the U.S. Department of Defense's (DoD) latest Base Realignment and Closure Act (BRAC), the expansion prepares the base for the influx of an additional 9,000 soldiers, Department of the Army civilians, and their families.

Adjacent to the southwest corner of the base on land managed by the University Multispectral Laboratories (UML), another project prepares for an influx of a whole different kind. The UAS project includes the installation of a 70' x 2,200' asphalt airstrip and installation of hangars and a flight control center. Uniquely positioned within Fort Sill's 200 square miles of restricted airspace, the advanced facility creates a one-of-a-kind commercial location to test, evaluate, train and conduct policy studies of UASs and their payloads, data systems, controllers and flight regimes.

Previously able to test only smaller aircraft – those that could be hand launched or needed just a limited amount of space for takeoff – this improved site allows the UML to test larger, more elaborate systems, which include associated single and multispectral sensors working within chemical, biological, radiological, explosive, radio frequency, thermal, meteorological and natural disaster environments.

"Both the Fort Sill and UML UAS projects complement each other," said Dave Ralston, the former commanding general at Fort Sill who now is president of TDRS Consultants. Ralston, along with partners at TDRS, are working closely with the UML to develop and advance the interoperability between the UAS facility and Fort Sill. "We have a unique set of variables here that makes Fort Sill a great place to operate UASs," he continued. "We also, because of the airspace, have a great deal of Army-Air Force inter-service activity to advance joint tactical operations."

That potential for inter-service activity was a key factor in Fort Sill's growth during the latest BRAC process. According to a May 13, 2005, DoD news release, one of the intentions of BRAC is to "consolidate similar or duplicative training and support functions to improve joint war fighting." Others include retaining installations with unique capabilities, and enhancing the military's ability to meet contingency and surge requirements.

The Army's Air Defense Artillery School relocated to Fort Sill during this latest round of BRAC recommendations. The school will be consolidated with the Field Artillery School already placed at Fort Sill. Additionally, Fort Sill trains Joint Fires Observers (JFOs) who

An unmanned aerial vehicle known as a Tigershark sits on the runway at the UML's new facility in Lawton.

work with the Air Force's Joint Terminal Attack Controllers (JTAC). In combat, JFOs work with deployed JTACs on the ground to identify targets for Air Force pilots in the skies above. "It's a service provided by the Air Force to the Army," Ralston explained.

Now, the location and operation of the UAS testing facility adjacent to the base will have an even larger impact on advanced training at Fort Sill. Ralston foresees numerous opportunities. "The UAS testing facility is a good fit with the Air Defense School since it will provide the soldiers another dimension for training by integrating the UAS variable into the JFO's mission," he said.

More notably, the facility provides Oklahoma with a distinct advantage over all other states as a leading UAS test, certification, education, policy study and training site for the DoD, federal agencies, academia and commercial enterprises. Additionally as a natural extension of local training within the Fort Sill and Lawton region, the UML desires the development of close collaboration with Cameron University to advance the UAS opportunities.

"UASs are finding more and more uses by all factions," said retired Maj. Gen. Al Goodbary, associate laboratory director for strategic affairs at the UML. "This is a huge and unique opportunity for Oklahoma to support the rapidly growing worldwide UAS industry through the UML's ability to fly UASs within restricted airspace."

An Explosive Market

Since 9/11 the DoD has taken the lead to rapidly advance unmanned systems capabilities to support wartime efforts. Market studies estimate that UAS spending will more than double over the next decade and total close to $55 billion over the next 10 years, said Ken Viera, retired U.S. Navy CWO-3 and associate laboratory director for programs at the UML. The DoD alone projects a five-fold increase in UAS use in the near future, and by Secretary of Defense mandate, one-third of the entire deep strike air force will be UASs by 2010.

Growth is inevitable in commercial markets as well. The Government Accountability Office (GAO) projects the number of UASs built for civilian use will increase

The Pterosoar-B, an unmanned aerial vehicle built by OSU students, launches at the UML's Chilocco test site on June 30, 2008. The vehicle set a world record for an electric-powered autonomous UAS systems under 5 kilograms staying aloft for 6 hours, 15 minutes and 54 seconds. Shown in the picture are Dan Bierly from Zivko Aeronautics (left) and OSU Professor Andy Arena (right).

more than four-fold within the next 10 years. According to the GAO, interest in using UAS for civilian applications is rising due to the development of new technologies, potential applications and the need to reduce costs.

"There are literally hundreds of UAS manufacturers, ranging from hobbyists to big companies like Boeing," Goodbary said. "Regardless of their application, they all require testing and the development of national and international policies that allow for the safe and efficient integration into our airspaces."

Ralston agrees saying, "UASs will have a huge commercial market." He included sectors like border control, traffic control, law enforcement and the use of sophisticated sensors tested in Lawton to be used in locating missing hikers, collecting weather data, monitoring power and pipelines, and responding to and aiding in the recovery from natural disasters.

Leading the Way

In an effort to lead change and impact this global UAS test, certification, policy, education and training market, the UML has created a consortium of university, industry and government partners known as Oklahoma Flight Innovation, Research, Test, and Scientific Testing-UAS (OKFIRST-UAS). The OKFIRST-UAS team currently consists of the UML, Zivko Aeronautics Inc., QinetiQ-NA, Oklahoma State University's School of Mechanical and Aerospace Engineering, Republic AERO, and the NASA Oklahoma Space Grant Consortium, which includes seven other state universities.

"We have reached out and continue to attempt to expand our team to include the University of Oklahoma, large federal contractors and out-of-state small businesses as well," Goodbary said.

Within 10 years, the team hopes to establish Oklahoma as the nation's leading state in research and commercialization of UASs and the new facility adjacent to Fort Sill is just a first step. By being proactive, the team believes Oklahoma could be ready and waiting with resources – not just facilities but also intellectual capital – to lead the nation in this emerging industry.

"This is a strategic, state-level initiative to move Oklahoma ahead of the industry curve, driving the state, its universities and commercial enterprises to become a focal point for testing, certification, education, policy study, training and manufacturing in not only UASs, but the wider unmanned markets of ground, water and submersible unmanned systems," Viera said. "Our consortium's vision and program execution sets in motion a state-level business strategy to support an international effort meeting the policy, regulatory, educational and technical skills needs of the burgeoning unmanned systems' markets."

Specifically, the UML's UAS vision has received strong leadership, guidance and support from Oklahoma's congressional delegation spearheaded by Rep. Tom Cole, Rep. Frank Lucas and a strong separate leadership and endorsement from Sen. Jim Inhofe, who are all keenly aware of the future UAS marketplace and have shaped the progression of this state-level vision and belief in Oklahoma's ability to lead both the national and international unmanned systems marketplace.

"Our congressional and senatorial members have done a wonderful job understanding this new marketplace and have led the way toward the acquisition and investment of two federal appropriations totaling more than $4 million into the UML's UAS facility, local workforce expansion and integration with Fort Sill operations," Viera said.

The OKFIRST-UAS team led by the UML in 2009 submitted a proposal to Oklahoma's Economic Development Generating Excellence (EDGE) Policy Board requesting funding from the EDGE program to support UAS research, development, testing, workforce training and significant jobs creation. The OKFIRST-UAS team believes that a state-level vision to harness Oklahoma's long aviation and engineering history can establish it as the "fly-to state" for unmanned aerial, ground, water and submersible systems and bring more than 600 new unmanned systems jobs to Oklahoma over the next 10 years, providing an economic impact exceeding $500 million.

"We don't want to play catch-up; we want to build a broad alliance of Oklahoma education institutes and business entities to lead at all levels of the marketplace," Viera said. "The success of the OKFIRST-UAS vision tied to a persistent state-level marketing message and growing unmanned systems opportunities worldwide can place Oklahoma at the center of these explosive unmanned systems markets, leading to the creation of new research, quality new jobs and new partners."

Sensors –Evolving Requirements to Meet Emerging Threats

A Review by Dr. Web Keogh,
Director of the University Multispectral Laboratories

The world has become dependent on sensors in much the same way that computers now dominate our society. On any given day a person will interact with hundreds of sensors, most going unnoticed but still integral to normal everyday activities. One of the richest and most densely populated areas to find sensors is in a car. These sensors can be rudimentary to very complex – simply measuring the amount of gas remaining or actively making safety decisions by monitoring the road conditions and distance between vehicles to automatically engage advanced systems that improve control and reduce vehicle speed.

The sensor field is ever expanding with current estimates on newly developed sensors in the thousands per year. These sensors have broad applications, from purely commercial to highly specialized for government defense, intelligence and security end-users. The new requirements supporting our national and homeland defense initiatives are evolving quickly. The change in requirements can sometimes be faster than next generation sensors can be developed making current state-of-the-art nearly obsolete prior to a first deployment.

Our warfighters, homeland security elements, police and first responders stand on the front line to defend and protect us against an ever changing and evolving threat. In order to counter these emerging threats, we must develop and implement new defensive capabilities that stay significantly ahead of the adversary in order to maximize our ever changing and unfortunately narrowing technological advantage. Therefore, the requirements for sensors and sensor-related technology are constantly evolving and in many cases overrun a normal research and development cycle. As a result, end-users and technology developers must attempt to meet these threats using formalized requirement documents while also predicting future threats and needs.

The Reality for Developers

After the terrorist attacks on September 11, 2001, and the initiation of the Global War on Terror, the federal government invested heavily in the development of new sensors for chemical, biological, radiological, nuclear and explosive (CBRNE) defense and advanced intelligence, surveillance and reconnaissance (ISR). While significant discoveries in these fields were made, the hope for truly revolutionary advances has not yet come to fruition.

Within the Department of Defense (DoD), there has been an overall reduction in the funding for basic or early-phase applied research that will lead to the next generation of sensors and operational capabilities. Two prime examples of this trend may be found within the Defense Advanced Research Projects Agency (DARPA) and the United States Special Operations Command (SOCOM). Collectively DARPA and SOCOM serve as the bellwethers for DoD research and operational requirements. DARPA has a mission to maintain the U.S. technology advantage and is the lead for DoD early-phase higher risk research. SOCOM and its operators are equipped and trained with the latest and most advanced technological solutions in order to conduct their missions in support of national security and against terrorist networks.

Driven by budgetary constraints and other core mission requirements, DARPA has pulled away from funding new sensor development programs over the past couple of years. At the Special Operations Forces Industry Conference 2009, SOCOM requested assistance from industry for the strategic reinvestment of internal research and development funds to support the early phase discovery of operationally relevant technologies. Both of these actions indicate a tightening and realignment of federal research and development funding especially within the sensor markets.

The reality for developers is the competition for federally sponsored research and development contracts and grants is becoming tighter as the number of sensors and sensor developers increase and available dollars decrease. Therefore to increase the funding opportunities developers must engage end-users and operators at significantly earlier stages of the research. This involvement enhances the development cycle and allows for the efficient and effective development and transition of new technologies.

Equal to the integration of end-user perspectives in establishing new operational capabilities is an understanding of how new technologies are assessed and evaluated across multiple risk criteria, e.g. operational, technical and programmatic. By combining these two areas, technology developers will be able to improve the positioning of their solutions to be equally understood and valued by the end-users, technical evaluators and acquisition executives.

High Priority Sensor Technology Needs

Many similarities exist between the sensor requirements for the DoD, the intelligence community, the Department of Homeland Security (DHS) and the commercial sector. The primary differences between these communities and their needs are the types of operational environments and packaging, support infrastructure, and acquisition budgets. For example, most systems targeted to the DoD will require sensor packages that are smaller, lighter and have greater power efficiency.

The specific needs within five core areas for the DoD and DHS include 1) threat and contraband materials detection and identification; 2) maritime and transportation inspection and intrusion detection systems; 3) biometrics and behavioral identification; 4) situational and operational awareness; and 5) infrastructure failure detection.

Threat and Contraband Materials Detection and Identification

The DoD, DHS and other government agencies have operational requirements for sensors that can address both threat materials and contraband, including but not limited to CBRNE agents, toxic

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industrial chemicals, narcotics, weapons and money. The sensors must be capable of quickly detecting and identifying both trace and bulk storage of these materials and operate in extreme environments and in the presence of multiple interferences, e.g. diesel fuel, Windex©, sunscreen, etc. It should be noted when discussing these types of sensors there is a discrete difference between detection and identification and developers should discuss in which of these modes their sensors operate.

With the increase in the use of improvised explosive devices (IEDs) overseas, the federal government has a significant effort spread across the DHS and DoD for the detection of explosive material and devices. Of particular interest is the non-intrusive detection and characterization of vehicle- and person-borne IEDs from a standoff distance. The DHS also has the requirement to screen people at fixed checkpoints, e.g. airport security lines, for explosives. The primary technical issue that needs to be resolved for the fixed checkpoint sensors is the current, slow detection rate that adversely affects the flow of passengers. Another area of concern in the explosives field is the detection and on-site characterization of homemade explosives.

Chemical and biological sensors still require additional development. Current-generation sensors still suffer from issues with specificity, detection limits, false-positive/false-negative rates, specific library development, power, etc. Biological detection and identification is a significantly greater challenge technically compared to chemical systems. As a result, needs exist for examining entirely different approaches to the detection of evolving and emerging biological threats.

Some of the key operational concerns for DHS are integrating handheld chemical/biological sensors without adversely affecting commerce. The technological innovations being sought must lead to advanced designs and implementation of these sensors in a non-intrusive method.

The DHS, and in some cases the DoD, must identify contraband, threat materials and people in hidden compartments or closed containers containing steel walls. New sensors are required that improve penetration, resolution, throughput, contrast sensitivity, reliability, mobility and interoperability. The technology must also be safe for human exposure and therefore the detection methodology must avoid x-ray, gamma rays and neutrons.

Maritime and Transportation Inspection and Intrusion Detection Systems

National defense and commercial enterprise share common operational requirements in defending maritime, land borders and transportation infrastructure; achieving personnel access control; and protecting physical assets. The DoD and DHS continue to identify the core difficulties faced in detecting and identifying threats in the following scenarios: tunnels, rugged terrain, concealing foliage, water obstacles, mountains and over the horizon.

An operational example in a maritime environment is the detection and tracking of small vessels. In order to accomplish this goal the sensor will have to operate in a wide-area surveillance mode and track the vessel from a port or inland waterway to over the horizon.

For transportation security, the DHS still requires full screening of all checked/carried baggage and air cargo, especially that which is break-bulk and palletized. In this scenario, non-intrusive automated sensor systems must be able to identify conventional and homemade explosives and explosive devices and weapons. Due to the quantity of cargo items, the scanning must be performed in a matter of seconds.

Intrusion is a significant issue for commercial and government entities. Intrusion detectors are needed to identify attempted or successful intrusions of buildings, rooms, containers, etc. For six-sided shipping containers, the intrusion sensor also should be able to detect CBRNE threats.

Biometrics Applications

Biometric detectors are being used increasingly in the commercial areas for positive identification and access control to facilities and/or information. The rapid/real-time identification of individuals in non-ideal environments remains difficult. In order to overcome these obstacles, enhanced systems will need to incorporate multiple types of biometric data, e.g. electronic fingerprints, iris scans, face. The sensor systems will be required to have state-of-the-art security features to prevent the release of personal information.

Both defense and homeland security use biometric sensors in different operating modes, which change the technical issues and gaps. For example, mobile biometric sensors are required to be handheld, ruggedized, and have secure wireless connectivity. These sensors need to have close proximity but still be non-invasive to the individual whose identity is being verified. Other applications including but not limited to people screening in crowds, protection of buildings, and intelligence gathering require remote standoff biometric detection with stated goals exceeding 100 meters.

Operational and Situational Awareness

Command staff in the battlefield require in-depth operational and situational awareness. DHS and emergency response personnel refer to this as a "user-defined operating picture." A number of current sensors exist that can provide both the DoD and DHS with individual data points, however these data points can come from disparate groups, e.g. intelligence partners, local law enforcement, ground troops, unattended sensors. As a result, a current need exists to develop systems that can fuse all of these data and present a clear picture of the situation and the environment. Sensor developers must be cognizant of these advances in order for their technology to easily report and transition information into these fusion tools.

Another critical requirement for full situational awareness is the identification of

individuals with the intention to do harm or to deceive. If these individuals can be targeted early, steps to thwart or mitigate the potential threat can be achieved in a safer or at least more controlled environment. As a result and for many of the practical applications, the preferred method of detection of this intent is through non-invasive behavioral sensors that can operate at stand-off distances.

Personnel monitoring is also key to operational and situational awareness. Advanced sensor systems have been implemented to provide information to decision makers and end-users on the safety, security and health status of operators and the environment in which they are working. For personnel monitoring the critical requirements include blue force tracking capabilities and physiological monitoring. While the operational environments and communication methodologies will be different between the DoD and DHS, applications in the core technical requirements are transferable.

The DHS has listed their two highest priorities as a 3-D locator system for emergency responders and physiological monitoring of firefighters. The former system must provide better than one meter accuracy in all dimensional axes so that deployed teams can be tracked through multi-story buildings. Firefighters as well as warfighters are at risk for serious injury from heat exhaustion, cardio/cerebral fatalities, and exposure to toxic materials. In order to reduce the risk to these personnel, sensor systems that monitor a variety of health indicators need to be developed. These sensors should be integrated into the personnel protective equipment worn by the personnel and have secure wireless connectivity.

Infrastructure Failure Detection

Corrosion and the other deterioration of infrastructure are critical issues for both commercial entities and government agencies at the federal, state and local levels. Bridges, levees and pipelines are some of the highest profile infrastructure items of interest due to past failures that have resulted in significant loss of life and property. The principal goal is to have sensors that can detect and provide early warning for potential failures. The size, diversity and potential remoteness of these infrastructure items all lead to significant technical challenges. Advanced power systems and remote polling/reporting will be integral for the successful implementation of new sensor systems.

Future Trends in Sensor System Development

The current trends in end-user and operator requirements for sensors are toward fully integrated systems that address multiple classes of hazards. For example, the DoD is funding work that can lead to either a single integrated sensor or networked sensor suites that can simultaneously address chemical, biological and radiological threats. The DHS has published requirements for dual chemical/biological agent detection for buildings and integrated CBRNE sensor reporting capability that is scalable so that other sensor systems can be added. In addition to covering a broader set of hazards, the next generation of sensors will need to incorporate advanced information and computing systems; cybersecurity; new safety and reliability systems; and operational tactics, techniques and procedures.

Many of the current CBRNE sensors still suffer from reliability issues with false positive and false negative rates that are unsatisfactory. Future systems are being sought that address this reliability issue through the use of round robin assessments and internal validation routines.

Another issue that hinders the broader use of some of the currently available sensors is the dependence on uniquely developed data libraries. These libraries are compiled using actual measurements of known materials against which sensor data from an operational environment is compared. The differences in environment, e.g. lab versus operational, and/or the presence of interferences can dramatically affect the sensor response. As a result the performance and utility of the sensors are directly proportional to the size and fidelity of the library and the quality of the sensor data from the field device.

Another issue with the use of these libraries is that they are not shared and are held in disparate databases like much of the scientific information on the threats. There are standing requirements and technological solutions that can fuse this collective information into a single architecture. With the successful fusion, other advances to the sensor systems may be made, including those that can be adaptive and ultimately predictive for identifying new or unknown threats.

In order to achieve these predictive goals, researchers are currently investigating the expanded use of neural networks, cloud computing and other advanced virtual modeling capabilities to develop these sensor algorithms. While these new advances are being made, there is also an emerging trend to make sensors and their data available online using a diverse set of end-users.

Sensors Magazine recently reported on this novel development and implementation of integrated online sensor networks. According to the magazine, "Countless sensors and security cameras are deployed in cities and major facilities such as ports and airports around the world. In many cases, owners of these sensors and cameras are making the systems accessible via the Web. By implementing standards in the devices' Web interfaces, disaster managers and first responders can then find and use these devices in a crisis."

The accessibility and sharing of sensor data via the Web is a significant force multiplier, especially for federal emergency management and state intelligence fusion centers. However, reliance on these types of networks to produce actionable intelligence and information adds new dimensions for sensor data reliability that will require critical subsystems to address information assurance and cybersecurity.

On the Cutting EDGE

Two sensor technologies make it to second round of EDGE review

Now in its second funding cycle, the Oklahoma Economic Development Generating Excellence (EDGE) endowment is impacting technology-based businesses and research throughout the state. Created in 2006 by the State Legislature, the endowment strives to bolster Oklahoma's long-term economic growth by investing in the state's knowledge infrastructure, according to the EDGE Web site. Focusing on key areas of advancement that include aerospace, biotechnology, energy and sensors, the fund provides necessary capital to projects that demonstrate the ability to create jobs, launch new companies and increase the flow of federal funding to Oklahoma.

In 2008, following an extensive review process, the EDGE Policy Board awarded more than $10 million to five projects. For 2009, the board will award approximately $7.5 million to an undetermined number of projects that complete the same review process. Sixty-five pre-proposals were submitted to the board for initial review in May 2009 for a total requested amount of $142 million. Fourteen of those 65 – including two sensor technology projects – were invited to submit full proposals to the board.

Both sensor technology projects represent the fusion of sensors with nanotechnology. Proposed by Oklahoma businesses, Amethyst Research, Inc. and SensorCorr, the initiatives seek to establish sensor manufacturing facilities in Oklahoma and commercialize technology needed in today's market.

Seeing in the Dark

If you've ever driven in the rain or fog at night, you understand the importance of the technology Amethyst proposes. The company, which began operations in 2005 at the Southern Oklahoma Technology Center in Ardmore, plans to develop and commercialize a new technology for infrared sensors that exploits the beneficial thermoelectric properties of nano-engineered silicon. In addition to the military and homeland security markets that are in need of small, low-power night vision systems, Amethyst's technology targets large commercial users in the automotive and robotic manufacturing industries.

Here's how one application of the technology might work: An infrared camera mounted under the hood of a car would feed a combination of infrared and visual images projected on the windshield within the driver's field of view – similar to the heads-up displays common to modern fighter aircraft – providing the driver a powerful new capability to "see" the otherwise unseen well down the road despite darkness, fog or smoke.

With EDGE funding, Amethyst will partner with researchers at Oklahoma State University and the University of Oklahoma on prototype development. All testing and certification will be conducted at the University Multispectral Laboratories (UML) in Ponca City.

According to Dr. Terry Golding, Amethyst's chief technical officer, the company's investigations into competitive technologies reveal that Japanese auto manufacturers are already developing similar infrared sensor systems for its vehicles. Golding believes this speaks to the future demands for low-cost consumer night vision sensors on which the OSU-Amethyst collaboration is focused. "Our technology," he stated, "will deliver significant improvements over emerging Japanese technologies, and, in keeping with EDGE objectives, will provide the base from which to launch a domestic manufacturing capability in Oklahoma."

The project builds on Amethyst's proprietary hydrogenation process, which the company currently employs to repair defects in substrate materials used in the production of infrared focal plane arrays – the basic building block of thermal cameras found in a wide range of applications from missile defense to medical diagnostics. The hydrogenation process, which Golding says has already proven to enhance the performance of other infrared sensors, will be utilized to improve the electrical conductivity of the silicon nanowires used in its new systems.

Under Amethyst's EDGE proposal the company expects to site future manufacturing facilities alongside its existing research and development facilities in Lone Grove, a suburb of Ardmore, Okla. Although the construction of the new plant will require funds over and above those coming from EDGE, Golding expressed confidence that with successful development of a prototype and validation from the UML, support will become available for transitioning to production. The proposal also projects creation of 30 new high-salary professional jobs by 2015.

"Oklahoma is already widely respected as a state where significant sensor research and development is taking place – indeed this is why we originally located Amethyst in Oklahoma," Golding said. "To turn that into truly meaningful job creation, including high paying jobs, we must create a sensor manufacturing base. We believe an EDGE award could be that catalyst, and the beginning of Oklahoma's rise to prominence as a sensor manufacturing state."

Detecting Catastrophe Before It Strikes

Corrosion is not often something many of us think about – until, of course, the bridge you cross on your way to work each morning is closed for repair or the aircraft flying you home for the holidays is grounded. Corrosion is over a $300 billion annual problem in the U.S., said Dr. Allen Apblett, an Oklahoma State University researcher and founder of SensorCorr. Apblett and colleague Dr. Nick Materer's EDGE proposal seeks to commercialize non-powered wireless corrosion sensors that could be optimized for application in the pipeline, highway infrastructure and aerospace industries.

Originally developed in Apblett and Materer's lab at OSU, the technology is based on low-cost, passive radio frequency identification (RFID) tags like those used for inventory and theft prevention of consumer goods. Once attached to an object or structure, the sensor transmits a characteristic signal from its RFID tag. It is the loss of or change in this char-

acteristic signal that indicates the presence of corrosion. A technician is able to detect the signals using a wand-type RFID reader.

Due to the wide availability of RFID tags and the packaged inventory control software that goes with them, Apblett said these systems are inexpensive to make and easy to use. These advantages allow the sensors to be easily placed at many locations and give them a greater utility over more complex sensor systems that report degrees of corrosion at fewer locations. In addition, low manufacturing cost allows the use of multiple sensors with different trigger levels. The sensors may be utilized to indicate a range of conditions from the point where preventive maintenance is required to the point where imminent structure failure is at hand.

In an effort to commercialize this technology, EDGE funding would be utilized to hire technical employees and establish a marketing team to penetrate the pipeline, highway infrastructure and aerospace markets. The project would directly expand the number of high-paying scientific and engineering jobs in Oklahoma and favorably impact other Oklahoma businesses that could provide supplies and professional services, Apblett said.

Commercial interest already exists for each of the market sectors the project plans to target. Preliminary forecasts show projected annual sales in excess of $1 million the year following EDGE project completion, and $10 million five years after project completion. During the EDGE program, SensorCorr, which is currently a portfolio company in Acorn Growth Companies' incubator, would continue to utilize OSU facilities while Acorn provides management assistance.

The EDGE Policy Board will select programs to receive funding in November 2009. For more information on the EDGE fund, visit *http://www.okedge.org*.

"Oklahoma is already widely respected as a state where significant sensor research and development is taking place ..."
— Terry Golding, chief technical officer, Amethyst Research, Inc.

What a Wonderful Web We Weave

"Web" is a term used to describe materials manufactured and processed in a continuous, flexible strip form. Examples include: plastics, paper, textiles, metals and films. Guiding of the web on rollers through processing machinery is essential for successful manufacturing of all web materials. Dr. Prabhakar Pagilla, professor at Oklahoma State University, plans to develop and commercialize a fiber optic sensing device to measure the lateral position of a web. Current sensing devices use either infrared or ultrasonic technology, which Pagilla says give an indirect measurement of the web lateral position. The fiber optic sensor is based on light scattering from the web and the directional sensitivity of the optical fibers, which according to Pagilla will provide a true measurement of the web lateral position. Pagilla has formed a start-up company called Indus Technology, LLC, to commercially develop the sensing technology.

Nanotubes All in a Row

Dr. Yu Mao, assistant professor at Oklahoma State University, is working in concert with NanoLab Inc. to develop an understanding of vapor-phase chemical activity in aligned carbon nanotubes. The research will have applications for biosensors, membranes and electronic nanocoatings. Functionalization of aligned nanotubes remains a challenge due to the difficulty of preserving the desirable alignment using traditional liquid-based methods. The long-term research goal of investigating functional nanostructures is to develop sensitive sensor devices; the objective of Mao's work is to understand the vapor-deposition functionalization of aligned carbon nanotubes. She and her team propose to introduce the radical chemistry of liquid-based methods into the vapor deposition process to retain functional groups and nanotube alignment simultaneously. Preliminary studies demonstrate successful functionalization of aligned carbon nanotubes using the vapor-deposition method. Further research is proposed to understand the chemistry of covalent and non-covalent functionalization of aligned nanotubes. The research will significantly advance capabilities in developing nanotube-based sensor devices and have broad impact on research activities in nanostructure engineering and thin films.

Open or Closed?

Professor Parameswar Hari of the University of Tulsa has discovered that zinc oxide nanorods can be selectively grown to produce open or closed nanostructures by controlling deposition conditions in a wet chemical process. Access Optics will work with Hari and the University of Tulsa on the project. The primary use of these detectors is in the form of sensors and medical monitors for anesthesia applications.

Tiny Growth

The soft matter nanotechnology and biological physics group of Dr. Bret Flanders, Kansas State University, has developed an electrochemical nanowire-growth technique that induces growing nanowires to pinpoint on-chip targets. The technology was initially developed by Flanders at Oklahoma State University, which owns the original intellectual property. The targets may be other electrodes or even living biological cells. Recently published work shows how to apply electric fields to lithographic electrode arrays to direct the growth of metallic and polymeric nanowires from a given electrode up to a user-selected target on the array. The technique is called directed electrochemical nanowire assembly. Flanders co-founded the company NanoGenix to fabricate nanoelectrode growth-kits for sale to researchers and educators who require nanowire-growth capabilities. These kits are expected to be available in 2010.

GRC DOWNHOLE INTELLIGENCE
GEOPHYSICAL RESEARCH COMPANY, LLC

Leading provider of downhole sensing technology on track for continued growth

Tulsa-based Geophysical Research Company, LLC (GRC) is a global leader in the design and manufacture of sensing technology used in downhole data acquisition applications for the oil and gas industry. Over the past four years, GRC has experienced robust growth, particularly in the supply of sensing technology for artificial lift, memory and permanent reservoir monitoring applications worldwide.

Recently, GRC celebrated several major milestones in the company's 84-year history, including the shipment of the 10,000th electrical submersible pump gauge and the successful installation of permanent downhole pressure and temperature systems in offshore West Africa.

Robert Laird, president and CEO of GRC said, "This is an exciting time for GRC, not only as we celebrate these incredible achievements, but also as we aggressively pursue new innovations in downhole sensing technology that enable our clients to evaluate their assets and develop a greater return on their investments."

GRC believes the rapid growth that has marked the last four years will only accelerate as newly developed downhole sensing technology enters the market.

For more information on GRC and downhole sensing technology, visit www.grcamerada.com or contact Eric Sallee at esallee@grcamerada.com or 918-280-2825.

Qual-Tron Inc. participates in border security exercise

Qual-Tron Inc., a Tulsa-based manufacturer of unattended ground sensors and intrusion detection equipment used by U.S. and foreign militaries, government agencies and law enforcement agencies, recently participated in a successful proof of concept exercise of a low-cost border security system. The yet unnamed system included Qual-Tron's unattended ground sensors, day and night cameras, ground radar, and UAVs all operating on a meshed network system and were displayed on a single graphic interface. The participating consortium coordinated with local border patrol authorities, resulting in actual apprehension of illegal aliens.

For more information on Qual-Tron products, visit http://www.qual-tron.com.

ICx Technologies introduces Fido® Verdict™

ICx Technologies (NASDAQ: ICXT), a developer of advanced sensor technologies for homeland security, force protection and commercial applications, has announced a new product based on a breakthrough in the miniaturization of Raman-based spectroscopy instruments. The company has redefined the field-based analysis of unknown materials with the introduction of Fido® Verdict™, a palm-size instrument for rapidly identifying suspicious liquids, solids and powdered materials.

Building on the Fido pedigree of highly sensitive detection systems, Verdict has been designed to help military and law enforcement officials identify explosives, dangerous liquids, narcotics and other threats commonly listed by agencies such as the Bureau of Alcohol, Tobacco, Firearms and Explosives and the Drug Enforcement Administration. Verdict uses well-established Raman spectroscopy technologies to identify suspicious materials in various forms, including substances in sealed containers. Verdict now enables accurate, field-based analysis

at security screening checkpoints, and in support of forensic investigations, while minimizing the exposure of first-responders and other users to potentially dangerous chemicals.

"Verdict will help ICx maintain our position as a world leader in developing portable, laboratory-caliber detectors for explosives, chemicals, radiation, and other threats," said Colin Cumming, CEO of ICx Technologies. "By adding Verdict to our other detection products like the Fido® XT™ explosives detector and Raider™ radiation source identifier, we have broadened the detection capabilities of our customers with another truly portable, field-ready precision analysis tool."

Verdict is a portable, easy-to-use and effective tool for use by armed forces combating IEDs, as well as for law enforcement as they fight illegal drugs.

For more information on the Verdict and other ICx Technologies products, go to www.icxt.com.

Oklahoma 100
HB1468 Quality Jobs Program

New program will position Oklahoma companies for federal funding

House Bill 1468, signed into law by Governor Brad Henry, provides direct incentives for federal contractors to use Oklahoma companies, and the Oklahoma 100 program has been created to streamline the process.

The University Multispectral Laboratories (UML) has developed the Oklahoma 100 program to effectively connect Oklahoma businesses with federal contractors, who will receive incentives through the state's existing Quality Jobs Program.

"HB 1468 is an important step to generate economic growth in our state and the Oklahoma 100 program has the potential to help bring millions of dollars in federal contracts to Oklahoma's small, large, urban and rural businesses," said OSU President Burns Hargis.

Hargis applauded Rep. Mike Jackson (Enid) and Sen. David Myers (Ponca City) for being the principal authors of HB 1468, which should help Oklahoma win more federal contracts and significantly improve its position nationally in research and development.

"The Oklahoma 100 program is a way to pull together all the Oklahoma companies that have the capabilities to meet critical national mission requirements through federal grants and contracts," said Dr. Web Keogh, laboratory director of the UML.

Oklahoma companies will be able to compete for federal projects by leveraging current state programs, such as the Oklahoma Bid Assistance Network, with the Oklahoma 100 program.

"HB 1468 and the UML's Oklahoma 100 program will not only significantly increase Oklahoma's stake in federal research and development," said Dr. Stephen McKeever, vice president for research and technology transfer at OSU. "It will also provide Oklahoma businesses access to a broader spectrum of services that the federal government requires."

"The extension of the quality jobs program to federal prime contractors will provide a new, large competitive advantage for Oklahoma and its businesses," Keogh said. "Oklahoma 100 will connect Oklahoma companies with prime contractors throughout the U.S."

SENSOR Companies in Oklahoma

Whether they are university spin-outs, have long-time ties to Oklahoma or simply located here to be close to sensor research, these companies are players in the global sensor industry. They are technology innovators, and their products and services meet needs.

Amethyst Research Inc.

Ardmore, OK

Co-founded by Terry Golding, a former university professor and scientist at the U.S. Army's Night Vision Laboratory, Amethyst Research Inc. manufactures large-area, low-cost substrates for the production of focal plane arrays, the building blocks for so-called "night vision" imaging devices used for everything from missile defense to medical diagnostics. Of intense interest to the Department of Defense (DoD), the technology, along with precision strike weapons, have come to define modern warfare. Due to their high cost, however, the sophisticated imagers have been well out of reach of the rank-and-file soldier, the life-saving first responder, or the breast cancer diagnostic clinic. Amethyst is out to change that.

"As a researcher at the Night Vision Lab I was appalled to learn what the military was paying for high-end infrared sensors. When a single focal plane array costs something north of a quarter million dollars, you know it's going to get into the hands of only the highest criticality users," Golding said.

The sensor array to which Golding refers is essentially the retina common to thermal cameras used in a wide range of military and commercial infrared imaging systems. Right now these are fabricated on costly foreign-made substrates. Seventy or 80 expensive processing steps later, only a handful of usable arrays will survive from a single wafer.

"It would be an enormous help to shift to big, cheap, domestically sourced silicon substrates, but they have, until now, been incompatible with the materials currently used," Golding said. While a university professor, Golding's research focused on solutions for neutralizing those defects and incompatibilities, specifically using hydrogen passivation.

Dr. Ron Hellmer performs a sample test with equipment at Amethyst's headquarters in Ardmore.

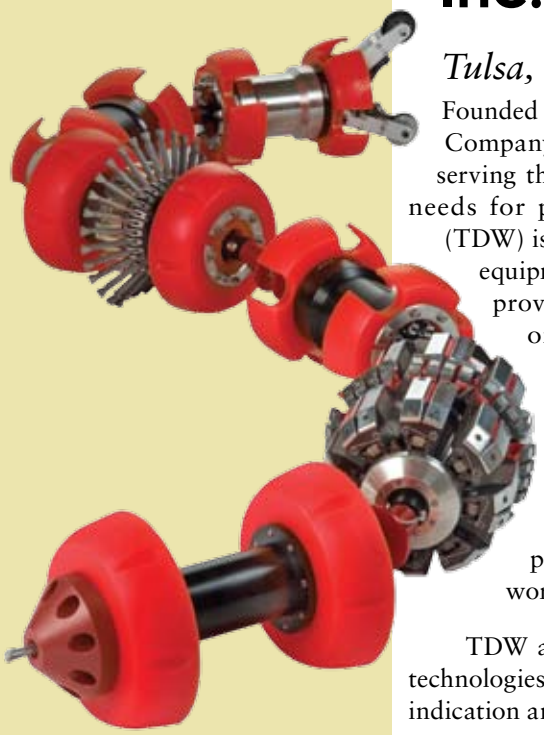
Golding formed Amethyst in 2005 and began operations in Ardmore at the Southern Oklahoma Technology Center. His decision to base the new start-up away from the usual high-tech havens was not an easy sell for co-founder Gary Schmidt, who was dubious at first about the company's ability to attract professional talent and to meet the company's eventual appetite for capital. "Terry's intuition was right on, as usual," Schmidt said. "Ardmore is just a great home for Amethyst. It has a 'can do' business attitude, ready access to Oklahoma City and Dallas-Fort Worth, and our people enjoy the sense of community and support of a small town."

In 2008, the company moved to a 5,000-square-foot facility in Lone Grove, an Ardmore suburb. Now with over $6 million in contracts in place – nearly all with the DoD – the company has 14 professional staff, and a second 5,000-square-foot building under construction to accommodate its growth. The firm expects another $8 million in contracts for 2010, and a commensurate increase in staffing levels.

Amethyst Research Inc.
1405 4th Ave. NW, Suite #345
Ardmore, OK 73401
580-226-2751
www.amethystresearch.com

T.D. Williamson, Inc.
Pipeline Performance

T.D. Williamson, Inc.



Pictured above is T.D. Williamson's PIG-SIG® NI XT Pig Passage Indicator and *(below)* the MAGPIE Corrosion Inspection Tool.

T.D. Williamson, Inc.
6801 South 65th West Avenue
Tulsa, OK 74131
1-800-828-1988
www.tdwilliamson.com

Tulsa, OK

Founded in 1920 as The Petroleum Electric Company, an electrical contracting firm serving the emerging petroleum industry's needs for power, T.D. Williamson, Inc. (TDW) is today a global leader in pipeline equipment and services. The company provides a comprehensive portfolio of safe integrity piping system solutions for onshore and offshore applications, including hot tapping & plugging, pipeline cleaning, geometry & MFL inspection, pigging and non-tethered plugging pig technology for any pressurized piping system, anywhere in the world.

TDW also develops leading-edge sensor technologies for inline inspection, pig passage indication and gas leak detection:

Designed with minimal mechanical parts and boasting the highest first-run success rate in the industry, high resolution MAGPIE® MFL tools provide accurate detection and sizing of internal and external metal loss and other ferrous anomalies.

The patent pending PIG-SIG® NI^{xt} passage indicator produces simple, reliable, non-intrusive detection of pig passages anywhere within a pipeline system. The unit is attached to the line, where it detects pigs equipped with magnets or featuring metallic brushes. No tapping is required, saving the operator time and money normally spent on the installation of conventional signal devices.

The GAZOMAT™ division of TDW provides leak detection and monitoring of natural gas distribution networks in the European market. The Inspectra® Laser Methane Detector is a highly sensitive tool that combines infrared absorption detection and laser technology with a tunable diode laser spectroscopy Herriot cell sensor. The combination of both technologies makes it an extremely efficient sensor, offering all the advantages of optical detection. To offer optimal safety for the drilling of probe holes or for job interventions on pipelines, GAZOMAT can also identify the location of underground cables and pipelines using ground penetrating radars and cable avoidance tools. Gazotox™ is a pocket personal protection device designed for use by operators who may be exposed to hazardous gas concentrations in their workplace. Depending on the type of sensor fitted, the detector measures hazardous concentrations of oxygen or toxic gases in real time.

Headquartered in Tulsa with manufacturing facilities and service centers worldwide, TDW delivers in-house engineering solutions; design, manufacturing and construction support; project management, training and consulting services to its customers in the pipeline, process piping, gas distribution, offshore, water and wastewater industries.

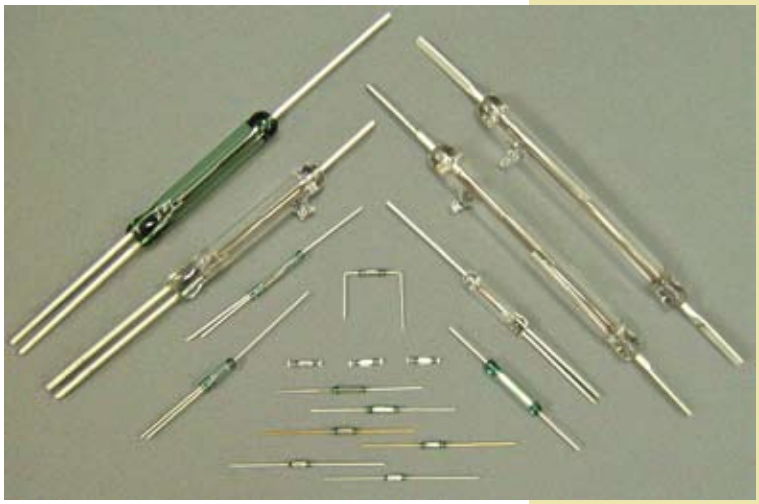
HERMETIC SWITCH, INC.

Switching and Sensing Solutions

Hermetic Switch

Chickasha, OK

Pictured above are Hermetic's overmolded micro reed switches, the PRX+2454. Pictured below are a variety of Hermetic's reed switches, from micro-miniature (4mm glass length) to high power (200 watt switching capacity). These can be placed into housings for a wider variety of mounting applications.



Based in Chickasha, Hermetic Switch is a privately held company that designs, develops and manufactures reed switches, proximity sensors and other switch technologies. Founded in 1968, the company is owned by its 250+ employees and serves clients in the medical implantable, hearing aid, aerospace, military and other industries. Hermetic maintains more than 550 active customers with numerous being Fortune 500 companies, said Sandy Sanders, marketing manager.

The company's product line includes both custom and off-the-shelf reed switches and proximity sensors. A highlight for the company was the design and development of the world's smallest and most magnetically sensitive reed switch, the HSR-0025. The innovative switch was designed to address the need for smaller electronic components in the medical and health-care industry, especially for hearing aids, pacemakers and other implantable devices.

Hermetic products are also used in defibrillators, Vagus nerve stimulators, space station/space shuttle components, astronaut space suits, satellites, commercial and military jet aircraft, artillery and anti-tank weapon systems, submarines, valve-position monitoring devices, vehicle component positioning/sensing, as well as test, measurement and diagnostic equipment (TMDE), burglar alarms, and wildlife tracking sensors.

Continuous growth and facilities expansions have characterized Hermetic's 40-year existence. Manufacturing moved to the company's present location in 1976. The physical plant has been expanded three times since that date. The most recent major expansion added 15,000 square feet of manufacturing space, including a state-of-the-art electroplating facility.

Hermetic's success in design and manufacturing has received acclaim and recognition. In 2006, the company received one of 14 Innovator of the Year awards sponsored by The Journal Record, an Oklahoma City business publication. The award honors exceptional Oklahoma companies on the leading edge of product and service innovation.

"Our mission is to be the switching and sensing solutions company customers seek out," Sanders said.

Hermetic Switch
3100 Norge Road
Chickasha, OK 73018
405-224-4046
www.hermeticswitch.com

XploSafe

Stillwater, OK

XploSafe LLC, based in Stillwater, was created in June 2009 to commercialize technology for the detection of peroxide, chlorate and nitro-based explosives through a variety of explosive sensors. The company serves national security clients such as airports, patrol officers, first responders and the military. They also serve commercial clients such as chemical, analytical and pharmaceutical labs.

"The need for a technology that can detect explosives rapidly and with complete accuracy has grown at an overwhelming pace over the years," said Liviu Pavel, chief financial officer for XploSafe. "These explosives pose a deadly risk to our society as a consequence of their preferred use by terrorists in the form of improvised explosive devices or IEDs."

As a result, XploSafe develops and manufacturers three types of sensor technologies:

- Nanometric ink used for detection of peroxide, chlorate, and nitro compounds found in improvised explosives.
- Test strips and sterile capillary tests used for detection of peroxide, chlorate, and nitro compounds found in suspect materials.
- Solvent protection pellets used for detection and neutralization of peroxide build-up in industrial solvents formulated in scientific laboratories.

Pavel believes XploSafe products will be successful, in part, because of their ease and efficiency of use. The company's test strips, for example, need only to come in contact with the air contained within the currently required plastic bag holding a traveler's liquids and gel-based products to detect an explosive substance. The presence of such a substance would result in a color change on the test strip. Since results are instantaneous, inspection requires only a brief glance at the package. Subsequent testing of suspicious liquids are sampled through a sterile glass capillary tube that will remove a drop of liquid and internally test for peroxide, chlorate or nitro compounds.

Additionally, the nanometric inks developed by XploSafe can be stored at ambient temperature, have a longer shelf life, and react instantaneously with the peroxide, chlorate and nitro-based compounds, which results in a dramatic color change.

The company builds on the work of OSU chemists Drs. Allen Apblett and Nick Materer who originally developed the color-changing reagent that, based on nanotechnology, can render explosives into non-explosive compounds. XploSafe is currently conducting a pilot program with the Oklahoma Highway Patrol Bomb Squad to field test its products.

"We anticipate that our products will be used on a daily basis at airport checkpoints, seaports, train stations and bus stations to test suspect packages by bomb squads and first responders," Pavel said. "Our mission is to reduce the threat of improvised explosive devices by developing technologies that detect and neutralize explosive compounds."

XploSafe
Stillwater, OK
405-334-5720
shoaib@xplosafe.com
www.xplosafe.com

(left) Explosive identification test using XploSens Explosive Identification Ink. (right) The ink reacts with the explosive compound to turn from dark blue to yellow/tan.

Lucas Newman Science and Technology

Stillwater, OK

Founded in 2002, Stillwater-based Lucas Newman Science and Technology's business revolves around its principal's personal abilities, said co-founder Dr. Art Lucas. Lucas, who came to Stillwater in 1995 for retirement, has more than 50 years of experience in radiation detection. His wife, Barbara, has a background in chemistry. Harry Newman, the company's other namesake, specializes in environmental remediation. These qualities create the perfect storm of expertise for the small company that, according to Art, seeks to provide "exceptional work in the measurement of radiation and radioactivity."

Lucas Newman serves its clients in one of three ways. The company provides devices for the measurement of radiation and/or radioactivity. They can also evaluate and certify a measurement system. Lastly, they can tackle the remediation of a contaminated environment. Currently, the company is working on a massive remediation project along the Cimarron River in western Oklahoma.

The company's other specialties include thick sample alpha spectroscopy, radon flux determination and border crossing devices, which use a sensitive array of gamma detectors to indicate the presence of concentrators such as marijuana.

From its offices in the Venture I building at the Oklahoma Technology and Research Park, Art said the company does most of its marketing through word-of-mouth and through connections with colleagues in professional societies. The company works throughout the U.S. and has completed projects in Alabama, Mississippi, Texas, Utah, South Dakota and many other states.

Above are photos from Lucas Newman's remediation project along the Cimarron River in western Oklahoma.

Lucas Newman Science and Technology
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Triarii Scientific

Tulsa, OK

A haz-mat professional employs Triarii's LiNK II to test a suspicious substance.

Created in 2006, Triarii Scientific develops sensors used to detect biological, chemical, radiological, nuclear and explosive (CBRNE) materials. The company provides complete product development services that include technology design and validation, prototyping, engineering, testing, certification and market commercialization.

In conjunction with the University Multi-spectral Laboratories in Ponca City, Triarii serves clients in the government/military sector that include the armed forces, National Guard, first responders, intelligence agencies, and the Department of Homeland Security.

The company's latest product introduced into this market, the LiNK II, allows first responders, technical specialists, military units and other emergency personnel to immediately collect and analyze suspected biological and chemical agents from sample material on-the-spot and in real-time. The technology was developed at The Lincoln Laboratories at MIT and has undergone extensive testing at the Naval Warfare Testing Laboratories.

"The LiNK II is an innovative biological and chemical in-field collection/detection system," said Charles Hess, president of Triarii. "It represents a significant breakthrough in frontline chemical and biological threat detection systems."

In addition to the government/military, Triarii also serves customers in the public/commercial sector. For this market, the company is currently launching a new technology called OverSite©. Provided in a vehicle that can be configured as a mobile, fixed or de-hutted facility, OverSite© combines communications, sensors and a command and control suite for the purpose of providing before-the- event preparedness for the protection of soft target venues and critical infrastructure assets. Soft targets are those frequented by gatherings of large public crowds typified by stadiums, sporting events, and indoor arenas such as concert halls and shopping areas.

Triarii's public/commercial customers include U.S. and international groups such as the National Football League, Major League Baseball, National Basketball Association and National Hockey League. The company also services individual stadium, coliseum and field facility owners/management as well as private and municipal facilities that often serve high visibility functions.

"Triarii's goal is to develop preconceived product/services that answer the anticipated and immediate needs for sensor technology, security enhancements, and protection services for both commercial civilian and government-supported entities," Hess said. "We intend to become a leader in identifying and creating sensor/security products and services."

Triarii's OverSite© vehicle stationed outside a soft target venue.

Triarii Scientific, LLC
7118 S. Columbia Place
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918-633-0344
chess@tri-sci.com
www.tri-sci.com

Business Accelerator Opens for Business In Stillwater

The Michael S. Morgan Business Accelerator Building at the Oklahoma Technology and Research Park has opened for business.

The structure features over 25,000 square feet of space – offices, buildable space and common space. 17,000 square feet are leasable, including seven fully furnished offices. The building leases on a structured increasing fee schedule or a flat rate for five years to encourage tenants to grow and then move into the local economy.

The Tech Park, located off of Highway 51 near Sangre Road in Stillwater, Okla., is an emerging knowledge center and high-value business destination for knowledge-based companies. Already home to the Stillwater branch of ICx Nomadics and OSU's Venture I building, a facility full of sensor-based research and companies, the Park is a 170-acre site master planned for one million square feet of lab, office and support space. OTRP is expected to bring more than 3,000 scientists and researchers to Stillwater.

A joint venture of OSU, Meridian Technology Center and the City of Stillwater, OTRP is designed to provide customized facilities for technology-based or knowledge-driven firms in all stages of development, whether seeking a single office, a laboratory, an entire floor of a building, or an entire building.

For more information on the OTRP visit their Web site at: www.oktechpark.com.

Oklahoma Technology & Research Park

Oklahoma State University
Office of Vice President for Research and Technology Transfer
203 Whitehurst
Stillwater, OK 74078-1020

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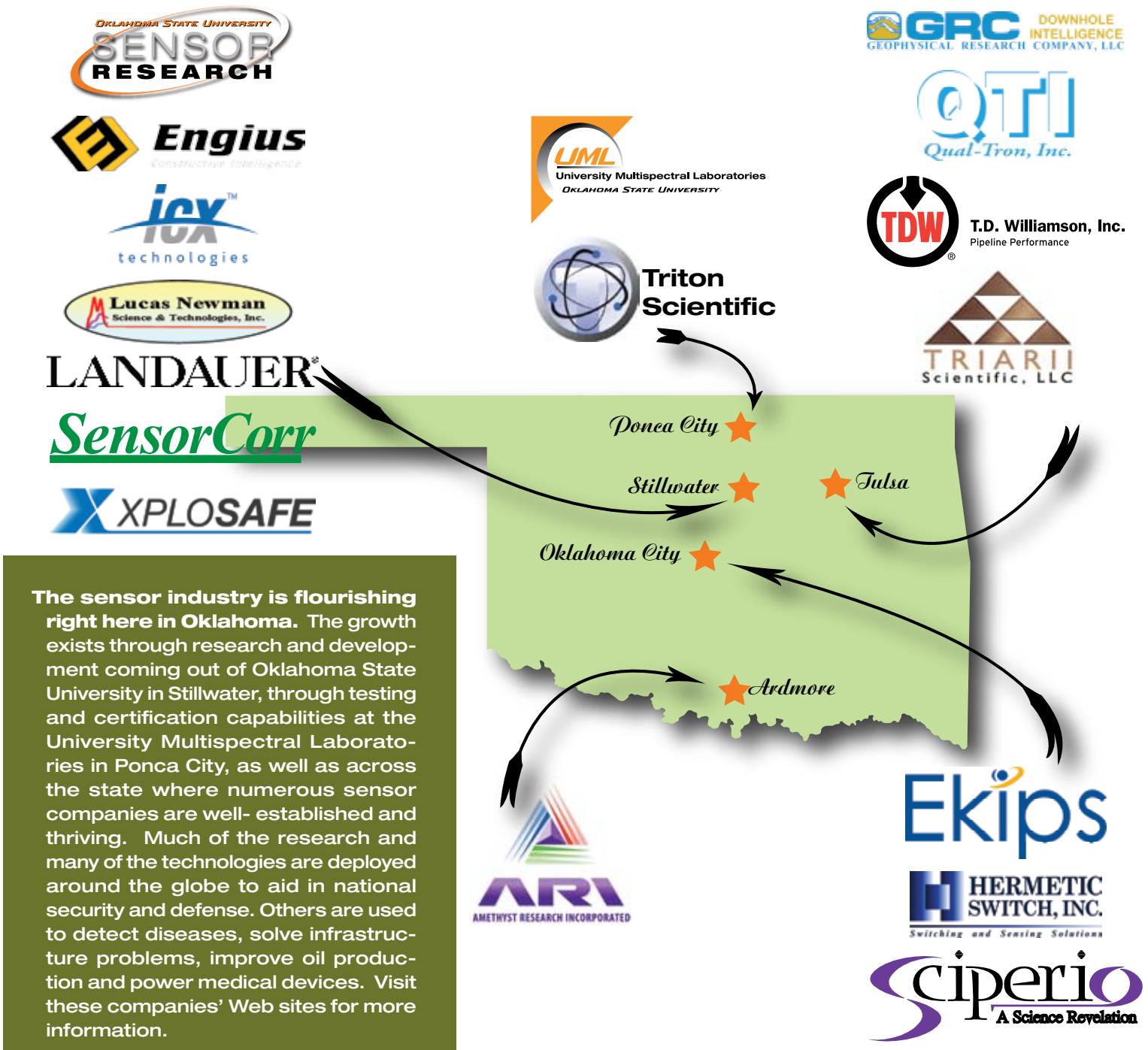

The sensor industry is flourishing right here in Oklahoma. The growth exists through research and development coming out of Oklahoma State University in Stillwater, through testing and certification capabilities at the University Multispectral Laboratories in Ponca City, as well as across the state where numerous sensor companies are well- established and thriving. Much of the research and many of the technologies are deployed around the globe to aid in national security and defense. Others are used to detect diseases, solve infrastructure problems, improve oil production and power medical devices. Visit these companies' Web sites for more information.